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Abstract

TECHNIQUES AND PROCEDURES FOR CONDUCTING MISSION ANALYSIS FOR STABILITY AND SUPPORT OPERATIONS: ANAPPLICATION OF SYSTEMS THEORY by MAJ Christopher R. Hupp, U.S. Army, 95 pages.

In June of 2001, the Department of the Army published FM 3-0: *Operations*. FM 3-0 specifies the principles for conducting Army operations across the spectrum of conflict ranging from military operations other than war to war. Significant to the publication is the recognition that stability and support operations are an integral element of all Army operations and will remain so for the foreseeable future.

Numerous stability and support operations conducted throughout the 1990s demonstrated that stability and support operations by nature occur in complex environments. The complexity is both structural and dynamic. The structural complexity is defined by the number of actors with independent objectives and policies, as well as demographic, political, and resource conditions that constrain the environment. The dynamic complexity is defined by the uncertainty of outcome and magnitude as the result of the interactions among the actors in the operating environment. Within such a complex environment, it can be extremely difficult for planners and commanders to identify where within the system of systems to apply effects to achieve desired ends.

Complex operational environments are not unique to the military. The fields of politics, sociology and biology all offer examples of both structural and dynamic complex situations. Practitioners in several disciplines have developed problem solving methodologies designed specifically to deal with complexity that are potentially useful to the military problem solver. Of particular potential is the work done in the area of general systems theory and several sub-disciplines to include hard systems, soft systems and operations research methodologies.

This monograph explores how existing systems techniques can be directly applied or modified to meet the requirements of mission analysis in stability and support operations. The study evaluates the adequacy of current mission analysis and intelligence preparation of the battlefield doctrine with respect to the stability and support operational environment. From that evaluation, the study derives requirements for systems theory based techniques and procedures for mission analysis. Existing systems techniques are then used to develop and demonstrate a notional, systems based mission analysis methodology.

The study concludes that systems theory can form the basis for useful, relevant mission analysis for the stability and support operational environment. Although the notional systems mission analysis model is presented herein as stand alone, the study recognizes that optimal application of the model is fully integrated with current doctrine, focusing systems techniques on problem attributes where system dynamics are largely unknown or undeveloped.

TECHNIQUES AND PROCEDURES FOR CONDUCTING MISSION ANALYSIS FOR STABILITY AND SUPPORT OPERATIONS: AN APPLICATION OF SYSTEMS THEORY

A Monograph
by
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INTRODUCTION

Background

In June of 2001, the Department of the Army published FM 3-0: *Operations*. FM 3-0 specifies the principles for conducting Army operations across the spectrum of conflict ranging from military operations other than war to war. Within the spectrum of conflict, Army forces accomplish assigned missions by executing combinations of the four basic types of operations: offensive, defensive, stability and support.[1] Joint Force Commanders and Army Component Commanders determine the emphasis that each basic operation receives relative to the assigned mission. Within the Army construct, higher-level missions serve as the general aim for the nesting of all combinations and sequencing of Army operations. Each type of operation though, maintains a distinct specific aim and purpose.[2]

Stability and support operations by nature occur in complex environments that make it difficult for planners and commanders to conduct thorough and relevant mission analysis. The complexity is both structural and dynamic. The structural complexity is defined by the number of governmental and nongovernmental entities with independent objectives and policies, as well as demographic, political and resource conditions that constrain the problem environment. The dynamic complexity is defined by the uncertainty associated with potential outcomes and their magnitude as the result of interactions among the entities within the constraints of the environment. Within such a complex operating environment, it can be extremely difficult to identify where within the system of systems to apply effects to achieve specified ends.[3]

The doctrinal military decision making process (MDMP) and specifically steps and procedures for conducting mission analysis is an inadequate tool for conducting mission analysis

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[1] Headquarters, Department of the Army, FM 3-0: *Operations,* (Washington, DC: GPO, 2001), 1-15.
[2] Ibid.
[3] Ibid., 9-5, 10-0.

in stability and support operations. The procedures and products of doctrinal MDMP are crafted to support decision-making where the application of force to achieve objectives is the primary consideration, e.g. major theater wars or small- scale contingency operations. In problem environments other than direct military action between opposing forces, doctrinal mission analysis does not offer the mental constructs (e.g. METT-TC), process or products required for adequate, proactive identification of probable decisive and leverage points with which planners and commanders can design operations.

Systems thinking is a proven method for conducting holistic analysis of complex problems. The techniques are well developed and documented for business applications. There is a distinct gap though between systems analysis techniques as instructed and practiced in civilian institutions and techniques and application in the military problem solving environment. Systems thinking concepts such as archetypes as proposed by Peter Senge may be valid for complex military problems, but we lack practical experience and examples for their application in realistic, military scenarios. In short, systems thinking is addressed repeatedly in concept, but there is yet to be produced any standardized techniques and procedures (systems doctrine) that military staffs and commanders can routinely apply to the stability and support operational environments.

Methodology

The first section of the monograph demonstrates both that stability and support operations are fundamentally different then combat operations and that the Military Decision Making Process is inadequate for mission analysis in stability and support operations. The section answers the subordinate question: Why is the Military Decision Making Process inadequate for mission analysis in stability and support operations?

The second section of the paper details current, practiced systems theory techniques and procedures and demonstrates their theoretical applicability to problem solving in stability and support operations. The section answers the subordinate research questions: How has systems thinking been applied to other complex problem solving environments?; Why does systems thinking offer a potential solution to stability and support mission analysis?

The third section of the monograph consists of an extrapolation and modification of systems techniques and procedures to the military problem-solving environment. In the course of detailing systems techniques and procedures, the process is applied against the 1994 support operation in Rwanda, Operation Support Hope. The section answers the subordinate research question: Is systems thinking conducive to standard techniques and procedures for military planners?

The final section presents conclusions and recommendations. The section answers the research question: Can systems theory form the basis for useful, standardized techniques and procedures for conducting mission analysis in stability and support operations?

MISSION ANALYSIS IN STABILITY AND SUPPORT OPERATIONS

The Complex Nature of Stability and Support Operations

All military operations and systems are complex in the sense that there are numerous variables, entities and constraints interacting in a great many and often dynamic ways. "Complex" though is not an objective adjective in the sense that there are no universal means to measure the level of complexity for a given problem. Complexity, and the degree of complexity, rather is subjective and based on several considerations. The most obvious consideration is the number of, and interactions among, the variables that define the structure of a problem. Second, is the ability of the person or system solving the problem.[4] Finally, there is the clarity of the desired end state for the problem. These three characteristics interact to shape not only the perception of

[4] Dietrich Doerner, *The Logic of Failure,* (New York, NY: Henry Holt and Company, Inc., 1996), 39.

complexity for any given problem environment but also the range of suitable means for solving or making decisions within the problem environment.

Structural Complexity

There are numerous ways to define complexity as it is applies to problem solving and describing the structure of a problem. Peter Senge identifies in his book *The Fifth Discipline* two types of complexity, detail and dynamic.[5] Detail complexity involves large numbers of variables such as with many industrial applications of linear programming that optimize systems of equations with thousands of variables and constraints. Dynamic complexity is different from detailed complexity in that it involves dislocation of cause and effect and unexpected outcomes from apparently obvious actions.[6] Senge further describes dynamic complexity as,

> When the same action has dramatically different effects in the short run and the long, there is dynamic complexity. When an action has one set of consequences locally and a very different set of consequences in another part of the system, there is dynamic complexity. When obvious interventions produce nonobvious consequences, there is dynamic complexity.[7]

Though not stated by Senge, both types of complexity he defines are independent but not mutually exclusive. For example, something as simple as the three variable, three equation system of equations discovered by Lorenz exhibits an infinite complexity in a never repeating pattern of output.[8] In his discussion of complexity, it is easy to interpret Senge's use of the term variable in the singular sense, that is as representing a finite entity such a number of soldiers or the level of unit moral. M. Mitchell Waldrop though identifies that variables can represent entire systems. Waldrop further develops the concept of dynamic complexity by identifying that how the system

[5] Peter M. Senge, *The Fifth Discipline: The Art and Practice of The Learning Organization,* (New York, NY: Doubleday, 1990), 71.
[6] Ibid., 364.
[7] Ibid., 71.
[8] James Gleick, *Chaos: Making a New Science,* (New York, NY: Penguin Books, 1987), 30.

of systems as a whole behaves because of the interaction of variables defines the complexity of a problem. Waldrop notes that interacting complex systems can undergo spontaneous self-organization, acquiring collective properties that they might never have possessed individually. Such self-organizing systems can also be adaptive, "actively try[ing] to turn whatever happens to their advantage."[9]

Under the combined definitions provided by Senge and Waldrop, Offensive, Defensive, Stability and Support operations are all detailed and dynamic, complex problems. Offensive operations such as the Ludendorff Offensive of 1918 demonstrate all of the components of complexity as defined by Senge and Waldrop: millions of men and thousands of machines conducting opposing offensive and defensive operations from which great initial tactical success for the Germans ultimately failed to achieve German strategic objectives.[10] Similarly, the U.S military conducted humanitarian assistance operations in Somalia beginning in 1992 in parallel with multiple international organizations and in the midst of opportunistic and adaptive Somali organizations.[11] All four types of military operation involve multiple organizations (systems) in direct competition or working in parallel, numerous singular variables, and actions that are subject to varying outcomes or measures of effectiveness at the tactical through strategic level of war. In a structural, linear sense Offensive, Defensive, Stability and Support operations are very comparable.

Though comparable in structural complexity, there is a difference in the U.S military's perception of the complexity of Offensive and Defensive operations compared to the perceived complexity of Stability and Support operations. That difference in perception is the result of the dominance of dynamic complexity in Stability and Support operations as opposed to the

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[9] Mitchell M. Waldrop, *Complexity: The Emerging Science at the Edge of Order and Chaos,* (New York, NY: Simon and Schuster, 1992), 11.
[10] Geofrey Parker, Ed., *Cambridge Illustrated History of Warfare* (Cambridge, UK: Cambridge University Press, 1995), 290-293.
[11] Terrence Lyons and Ahmed Samatar, *Somolia, State Collapse, Multilateral Intervention, and Strategies for Political Reconstruction,* (Washington, DC: The Brookings Institution, 1998), 36.

dominance of detail complexity in Offensive and Defensive Operations. This difference in the nature of the structural complexity of the problem environments results from the interaction of problem aim and problem solving experience with problem structure. The clarity in aim and purpose characteristic of Offensive and Defensive operations coupled with the U.S. military's experience with Offensive and Defensive operations shapes the problem environment to where many uncertainties in cause and effect are reduced to the point that analysis is largely detailed and systematic. This is in stark contrast to Stability and Support operations where often-ambiguous aim and purpose coupled with relative inexperience combine to create a problem environment where dynamic complexity dominates analysis and mission accomplishment.

The Influence of Problem Aim on Perceptions of Complexity

The most basic concept of problem solving offers insight into the central importance of aim to the complexity of a given problem. Proactive problem solving involves understanding where you currently are at, specifying where you want to go – an end state or objective, and then determining the way or ways of getting from the present to the objective. Backward planning of this nature starts the planner at his objective in order that the conditions that are required and the means that are available provide direction to the planning and execution process. The effect on the perception of the complexity of a problem is that the clearer the objective, the more bounded the problem is, and the less uncertainty there is to potential lines and logical lines of operation. The output for the Lorenz equations (Appendix A) provides a graphic example of this concept. Even though the numeric output, or end state, for the Lorenz system of equations never repeats, the pattern of the output is bounded. Looked at linearly, without consideration to the end state pattern, the Lorenz system of equations produce never repeating output – apparently random output too complex to predict. However, considered from the perspective of the known pattern of output, the output from the equations is generally predictable because there are clearly discernable bounds to the range of output. One can thus see the advantage in having an unambiguous end state – a consistent, well defined end state or problem aim bounds the problem reducing the general uncertainty.

In light of the influence of problem aim on perceptions of complexity, the aims of the four operations provided in FM 3-0 are indicative of a fundamental difference in the patterns of offensive and defensive operations vis-à-vis stability and support operations.[12]

> Offensive operations aim at destroying or defeating an enemy. Their Purpose is to impose US will on the enemy and achieve decisive victory.
>
> Defensive operations defeat an enemy attack, buy time, economize forces, or develop conditions favorable for offensive operations…Their purpose is to create conditions for a counteroffensive that allows Army forces to regain the initiative.
>
> Stability operations promote and protect US national interests by influencing the threat, political, and information dimensions of the operational environment through a combination of peacetime development, cooperative activities and coercive actions in response to crisis.
>
> Support operations employ Army forces to assist civil authorities, foreign or domestic, as they prepare for or respond to crisis and relieve suffering.

Three characteristics of the FM 3-0 aim and purpose of offensive and defensive operations separate them from the stated aims and purpose for stability and support operations. Both offensive and defensive operations involve the application, or the threat of the application of force against an enemy in order to destroy or defeat him. U.S. Army doctrine is very specific in defining key terms within the aim and purpose of both offensive and defensive operations such as destroy, defeat, and economy of force.[13] The aim and purpose of offensive and defensive operations are also wholly consistent with the traditional role for the Army to fight and win the

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[12] Headquarters, Department of the Army, FM 3-0: *Operations,* (Washington, DC: GPO, 2001), 1-15
[13] Headquarters Department of the Army, FM 101-5-1: *Operational Terms and Graphics*, (Washington, D.C.: GPO, 1997) Destroy, 1-51, Defeat, 1-47; Economy of Force, 1-58.

nation's wars.[14] These conditions result in little ambiguity to the desired end state in offensive and defensive operations. An example is the draft strategic directive for OPERATION DESERT STORM, in which the plans chief for Central Command determined a specified task of CENTCOM to be, "...If necessary and when directed, conduct military operations to destroy Iraqi armed forces..."[15] Regardless of the enemy, or the beginning state of the enemy force, the general end state remains the enemy system's destruction or defeat. In the Kosovo war too, where there was much controversy as to the ways of the operation, there was clear aim in both avoiding a larger humanitarian catastrophe and Serbian compliance with Rambouillet.[16] Given different enemies and different theaters of war, the fulfillment of aim and purpose for offensive and defensive operations results in a recognizable pattern – "the destruction, removal or containment of something present but not desired."[17]

The Army accomplishes the destruction, removal or containment of enemy forces in Offensive and Defensive operations through the imposition of entropy on a stable or steady state system. A cursory, anecdotal look at the pattern of historical Offensive and Defensive operations reveals just such consistency. Offensive and Defensive operations normally begin with both (all) belligerents at a low degree of entropy – that is they are organized and functioning at a level below the edge of chaos, able to pursue independent aim. The acts of offensive and defensive operations are then aimed at pushing the entropy of the opposing system beyond the edge of chaos, to that point at which the system is no longer able to pursue its aims and is forcefully subjected to the will of the opposing side (system). On the ground, it is that point where the cohesion and discipline of an organization breaks and the unit ceases to fight as a unit. Operationally it is that point where higher headquarters no longer has the ability to synchronize and coordinate the actions of its subordinate elements in time, space and purpose in the face of

[14] Headquarters, Department of the Army, FM 3-0, 1-2.
[15] GEN H. Norman Schwarzkopf with Peter Petre, *It Doesn't Take a Hero,* (New York, NY: Bantam Books, 1992), 387.
[16] Tim Judah, *Kosovo: War and Revenge,* (New Haven, CT: Yale University Press, 2000), 233.

enemy actions. Waldrop and US doctrine recognize that there will be self-organizing and adaptive subordinate elements within the collapse of a complex opposing system, but the net effect is such that the higher system that is forced into and kept in a chaotic or uncontrollable state is defeated.

Substitute any enemy force into the problem environment of Offensive and Defensive operations and immediately a mental model of what the general end state must be is available. At issue are the specific conditions of and ways for achieving that end state that generally are matters of mechanical complexity given the knowledge base and control mechanism of the US military. There is uncertainty with the outcome of any Offensive and Defensive operation, but any outcome is consistent with the general pattern of Offensive and Defensive operations – defeat or destruction of one of the participating systems.

In contrast, the aims and purpose of stability and support operations are relatively ambiguous. Doctrinal definitions for key terms such as promote and assist do not exist or, as in the case of the term protect, exist but only in a tactical context.[18] Regardless of the availability of precise definitions, also absent from stability and support operations' aim and purpose are effects directed at a tangible enemy force. Instead, stability effects are directed upon threat, political, and information environments with respect to U.S. interests while support operations' effects are subordinate to civil authorities. Terrence Lyons and Ahmed Samatar make one of the best characterizations of this problem environment:

> The [Somalia] story is complicated further as different components and individuals within each phase of the international operation pursued divergent if not contradictory agendas. Differences were sharp among officials in New York, Washington, Rome and other capitals, who produced ideas in response to their perceptions of developments, and international agents in the field, who by necessity had to react quickly to a different set of rapidly changing and confusing events on the ground.[19]

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[17] Russell L. Ackoff, *The Art of Problem Solving,* (New York, NY: John Wiley and Sons, 1978), 19

[18] Headquarters Department of the Army, FM 101-5-1, 1-125.

[19] Lyons and Samatar, *Somolia, State Collapse,* 36.

Stability and support aims are thus situational and therefore highly variable given US policy and equally significant foreign policy for any number of potential national and international situations.

Within the variability of Stability and Support operational aims and potential end states, there is a pattern though. Review of all of the types of stability and support operations as described in FM 3-0 reveals that they have in common the effect of "acquiring or attaining something that is absent but desired."[20] Stability and support operations can be viewed as creating steady state conditions in unstable or chaotic systems. Unlike with Offensive and Defensive operations, one cannot substitute entities for any given Stability and Support operation and maintain the same general mental model for the operations end state. As Waldrop noted in describing the complexity of the interaction of systems, the end-state is dependent on the aims of all of the systems interacting in the problem environment – different systems (e.g. nations) results in different dynamics. Lyons' and Samatar's description of Somalia again serves as an example where multiple entities have different and in some cases conflicting perceptions of what needs to be done – severally complicating the identification and understanding of cause and effect relationships.

Ironically, it is much easier to conceptualize and describe the reduction of a stable system to a chaotic state than it is to visualize and describe end state conditions for an unstable or chaotic system with which we intend to impose and maintain some degree of stability. Very much unlike Offensive and Defensive operations, at issue with Stability and Support operations are not only the specific conditions of and ways for achieving end state, but also the bounds and the interactions significant to the problem. Because Stability and Support operations are an effort to impose or maintain steady state conditions, of primary issue is the identification of dynamics that exist as the result of the interaction of systems – conditions that are very specific to the aims of the systems present and interacting in the problem environment. There is uncertainty with the outcome of Stability and Support operations. The general pattern of Stability and Support operations (acquiring or attaining something that is absent but desired) and the fact that the pattern itself can be spontaneous, adaptive and therefore variable further complicates problem definition.

Through the comparison of aims for Offensive and Defensive with those for Stability and Support operations, it is evident that there are fundamental differences between the operations. Offensive and Defensive vise Stability and Support operational aims define different problem types, "those involving the destruction, removal or containment of something that is present but not desired, and those involving the acquisition or attainment of something that is absent but desired."[21] Problem type has relevance to the final factor in the perception of complexity for any given problem: the skill of the individual or system solving the problem. Military history, theory and doctrine inform and define this aspect of military problem solving.

Adequacy of Mission Analysis Doctrine in Stability and Support Operations

The Influence of Experience on Perceptions of Complexity

The final aspect shaping the perception of complexity in Stability and Support operations vis-à-vis Offensive and Defensive operations is experience. Dietrich Doerner in his book *The Logic of Failure* explains that experience affects problem solving in two ways. First, experience allows individuals to develop "supersignals" which allow them to react to problems without having to individually process every piece of information pertaining to the problem. Secondly, experience provides for "structural knowledge" of how variables are related and influence one another.[22] Doerner indirectly identifies that there are both individual and institutional aspects to experience at problem solving that apply to the military operational environment. Individuals can

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[20] Ackoff, *The Art of Problem Solving,* 19
[21] Ibid.
[22] Dietrich Doerner, *The Logic of Failure,* 39-40.

have varying degrees of personal experience that they bring to any problem situation as can institutions.

The U.S. Army as an institution has numerous tools by which it conveys experience derived structural knowledge. "Fighting and winning the nation's wars is the foundation of Army service – the Army's non-negotiable contract with the American people and its enduring obligation to the nation."[23] Toward that end, theory, doctrine, tactics, techniques and procedures are oriented on how to manage the complexity of war in order to achieve desired effects. Collectively our current history, theory and doctrine form an expansive knowledge base, covering both detailed and dynamic aspects of military operations, with which we are able to train educate and conduct military operations.

In order to cope with the detailed complexity of Offensive and Defensive operations, the U.S. Military has produced a host of references. Technical sources for information include the Joint Munitions Effects Manual (JMEM) that details probabilities for the hitting and killing/destroying all types of munitions and ordinance against an exhaustive range of targets. Doctrine such as FM 34-130 provide for means to determine force ratios for use in calculating the sufficient forces necessary to successfully conduct tasks in Offensive and Defensive operations.[24] Numerous subordinate manuals and publications take the keystone information from FM 3-0, expand, and further define the concepts presented to the degree of specificity requisite for the organization and function for which the subordinate publication is designed. The result is that for many of the detailed variables common to Offensive and Defensive operations, there are probabilities in the place of unknowns. The effect on complexity is that variables in an Offensive and Defensive operation that would otherwise exhibit dynamic aspects as the result of uncertainty in cause and effect relationships are reduced to largely detailed problems.

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[23] Headquarters, Department of the Army, FM 3-0, 1-2.
[24] Headquarters, Department of the Army, *FM 34-130: Intelligence Preparation of the Battlefield,* (Washington, D.C.: GPO. 1994), B-38.

Similar to our mechanisms for quantifying many of the variables associated with Offensive and Defensive operations, we have a basic understanding of how variables relate and effect one another as the result of the interaction in the course of Offensive and Defensive operations. Doctrinal concepts such as the elements of combat power, the tenets of army operations, and even the principles of war are expressions of our general understanding of how variables must be combined, synchronized and optimized to achieve desired effects.[25] Doctrinal procedures for command and support relationships demonstrate an awareness of both the benefits of combined arms operations and the detrimental effect of no unity of command.[26] Similar to the effects achieved with respect to singular variables, U.S. Army theory and doctrine reflect deductions of interactions significant to Offensive and Defensive operations. In place of uncertainties and unknowns, theory and doctrine provide bounds to the Offensive and Defensive problem-solving environment.

Structural knowledge gained through experience, combined with clear operational aim and purpose enable problem solvers in Offensive and Defensive operational situations to logically and probabilistically link means with ends. What makes the understanding and predictability of cause and effect possible in Offensive and Defensive operations are the science we are able to apply against many of the variables (be that precise measurements of relative weapons capabilities or deductions of cause and effect made from the historical analysis) and the fact that there is clear aim in Offensive and Defensive operations. Any determination of probability of outcome is predicated upon knowledge of the possible outcomes – in the case here the aim of defeat or destruction of an enemy force. The existence of a history of Offensive and Defensive operations with patterned, clearly definable outcome enabled analysis necessary to deduce cause and affect relationships that define the structural complexity of Offensive and Defensive operations. It is thus because of a combination of clear aim and structural knowledge gained through experience

[25] Headquarters, Department of the Army, *FM 3-0,* 4-3.
[26] Ibid., 4-29.

that Offensive and Defensive operations are dominated by detailed complexity – the Offensive and Defensive problem is one of application of existing structural knowledge.

U.S. Army understanding of the detailed and dynamic complexity extends to stability and support operations. Similar to Offensive and Defensive operations there are several doctrinal manuals that detail the institutional knowledge the U.S. Army has developed in the course of conducting Stability and Support operations since the Army's inception. Theory and doctrine for operations other than war such as FM 100-23: *Peace Operations* specify separate significant variables and principles for peace operations – an indication in and of itself to a fundamental difference between Offensive and Defensive operations and Stability and Support operations.[27] There is an interesting distinction though between Offensive and Defensive doctrine and Stability and Support doctrine that results from the difference in the dominance of detailed and dynamic complexity in the respective problem types. Structural knowledge of Offensive and Defensive operations provides for clear, prescriptive procedures, objectives and methodologies for conducting analysis necessary to define the problem environment sufficient for commanders to effectively visualize, describe and direct operations. With respect to Stability and Support operations, doctrine is at times exhaustive in detailing "things" to collect without sufficient explanation as to why and what to do with the information once collected.[28]

Mission Analysis and IPB in Stability and Support Operations.

Of course, the problem boundaries, uncertainty and predictability discussed to this point are not of a high order of detail or specificity. The output of Lorenz equations is still unpredictable within the problem boundaries. The significance of the degrees of clarity and certainty that are achievable is that they are sufficient to define a problem type. Problem typing is common in mathematics and done for distinctions in the mechanics of a problem (e.g. geometric

[27] Headquarters, Department of the Army, *FM 100-23: Peace Operations,* (Washington D.C.: GPO, 1994), 12-19.
[28] Headquarters, Department of the Army, *FM 34-130,* 6-1 – 6-19.

vs. algebraic), relationships of variables within the function (linear or nonlinear), and even the general goal or aim of the problem (scheduling vs. max flow optimization models). Within any given type of problem, there are numerous numbers of variables, combinations of variables and outputs. However, regardless of those specifics, every problem type has characteristics that are unique and directly affect the manner in which organizations can most effectively solve the problem. For example scheduling and max flow are both types of optimization problems. Each can have varying degrees of detailed and dynamic complexity. However, the general aim of both problem types is different enough that the techniques for solving the two problem types are different. Though both are linear programming models, attempting to set one problem up using the techniques for the other problem type is at best inefficient and will most probably result in no solution to the problem. The same distinction separates Offensive and Defensive from Stability and Support problem types. As demonstrated, both types of problems are structurally complex, but more importantly they are divergent in their general aims and in the dominance of complexity type to the point of causing the techniques and procedures used for one to be ineffective and sub-optimal for the other.

Problem solving is synonymous with decision-making. "FM 101-5 is the U.S. Army's doctrinal source for the military decision making process (MDMP), the doctrinal approach to decision making that helps the commander and his staff examine a situation and reach logical decisions."[29] MDMP is a rational choice decision-making model in that it follows a classical decision analysis method in which decision makers identify a set of options, identify criteria by which to evaluate the options, weight each evaluation criteria, rate the options, and select the option that rates the highest.[30] Implied in the classic decision analysis methodology and explicit in the MDMP is the requirement for the decision maker to both have an understanding of the current

[29] Headquarters, Department of the Army, *FM 101-5: Staff Organization and Operations,* (Washington D.C.: GPO, 1997), vii.
[30] Gary Klein, *Sources of Power: How People Make Decisions,* (Cambridge, MA: The MIT Press, 1998), 10.

conditions and situation as well as knowledge of the end state or aim that the set of available options are designed to fulfill. Taken together, a problem is then defined when three aspects are detailed: current state or conditions, desired end state, and the way or ways of getting from current state to end state.

Mission analysis is the critical second step in MDMP that informs commander visualization and defines the problem (decision to make), providing the information requisite for determining feasible, supportable and acceptable courses of action. Within the construct of problem definition, mission analysis addresses the determination of the current condition / situation and the desired end-state or aim for the problem. Related to the discussion of complexity in chapter 1, mission analysis then is central to defining the both the structure and aim of the problem environment. MDMP doctrine represents the U.S Army's institutional knowledge applied against how to go about rationally solving the problem of selecting the best coarse of action for a given operation. At issue is the adequacy of the U.S. Army's rational choice decision model given the divergent nature of Offensive and Defensive vis-à-vis Stability and Support problem types. More specifically, is mission analysis adequate to serve the information requirements for both a detailed complex problem with relatively clear aim as exists with Offensive and Defensive operational problems and at the same time meet commander's needs for defining the structure of and determining appropriate aim for the Stability and Support operational environment?

The seventeen-step mission analysis process is largely appropriate to any military operation, but there are steps and products that are highly tailored to the Offensive and Defensive operational problem. The tailoring represents a purposeful departure from a generic problem solving methodology to a more specialized methodology that takes into consideration U.S. Army organization and missions. The result is a process providing staffs and commanders with direction as to both what to do and how. Specificity as to "what" and "how" is where the inadequacy of MA doctrine with respect to Stability and Support operations becomes evident. Given that

Offensive and Defensive operations are a different problem type than are Stability and Support operations, what MA needs to accomplish and how it should be done will not necessarily be the same for both types of problem. The shortcomings of MA to defining the Stability and Support operational environment are manifested in procedures and products for IPB and in how the information gathered in the course of MA is related and represented.

IPB is a significant step within MA, and in particular is tailored to Offensive and Defensive operations – a chapter on IPB in operations other than war not withstanding. The principles of IPB as specified in FM 34-130, though stated in Offensive and Defensive terms are relevant to all operations.[31] With respect to Offensive and Defensive operations, FM 34-130 is prescriptive in both what needs to be done and how. This is evident in chapters two and three that detail the conduct of IPB and provide example applications of IPB respectively. Both chapters go into specific detail on not only what needs to be done with respect to Offensive and Defensive operations but also how it can be done – with emphasis on the graphic means to both represent and analyze available information. Techniques as prescribed in the manual are consistent with a relatively well-understood problem environment, one in which the relationships among variables are well understood and not problematic. In that type of problem environment, cause and effect relationships are taken as largely given and the focus of analysis is on identifying system (enemy and friendly) objectives and alternative ways of achieving them.[32] Procedures and standards for development of enemy courses of action as a primary product of IPB is further evidence that IPB is in many respects specific to the Offensive and Defensive problem type.

Russell Ackoff noted in his book, *The Art of Problem Solving,* that the "less we understand something, the more variables we require to explain it."[33] Chapter six of the FM 34-130 is dedicated to IPB in stability and support operations. Of note in the chapter is the

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[31] Headquarters, Department of the Army, *FM 34-130,* 1-5.
[32] Peter Checkland, *Systems Thinking, Systems Practice,* (West Sussex, UK: John Wiley and Sons, 1999), 162.
[33] Ackoff, *The Art of Problem Solving,* 111.

recognition of the requirement to collect additional information significant to problem solving in the Stability and Support operational environment, but lacking is what exactly to do with the information. FM 34-130 goes along way toward identifying additional information requirements without specifying what should be done with the information beyond considering it's effects on the problem. Considerations for humanitarian operations covered in chapter six includes several pages of additional information that must be gathered and processed with no explanation as to why the additional information is required or how the information is used once collected. In chapter three, there are applications of IPB to several Stability and Support operational problems – conveniently all of which are focused upon situations were prescribed techniques for Offensive and Defensive operations are applicable.[34] There is intuitive value to the information requirements enumerated in chapter six, but what does the staff officer do with information collected about emergency services, law enforcement agencies and housing availability –how does one determine the relevance or significance of the information?[35] In the question lies the inadequacy of MA doctrine with respect to Stability and Support operations. Doctrine reacts to the different nature and complexity of Stability and Support operations by prescribing more information with which staffs can analyze the problem environment. The problem with Stability and Support operations, as already noted though, is not only with detailed complexity (the number and type of variables) but also with the effects of the relationship of the variable and often ambiguous problem aim. FM 34-130 correctly identifies the need for a broader scope of information (variables) significant to the problem type, but fails to address how to deal with the dynamic aspects of the problem.

Directly related to the problem of what to collect and why for purposes of IPB is the determination of initial commander's critical information requirements (CCIR). CCIR, as stated in US mission analysis doctrine, "identify information needed by the commander to support his

[34] Headquarters, Department of the Army, *FM 34-130*, 3-55 (Counterinsurgency Operations); 3-76 (Noncombatant Evacuation Operation).

battlefield visualization and to make critical decisions…"[36] If in fact the SS operational environment is dominated by detailed complexity, then CCIR must support the identification and representation of the complexity in order that commanders and staffs can incorporate the information into planning. As pointed out, current doctrine largely does not provide a means to determine and represent significant relationships in situations other than the Offensive and Defensive problem type. Required is a language and technique to focus collection of information that will facilitate commanders and staffs in modeling the problem environment.

Given that Stability and Support operations are dominated by dynamic complexity, what is necessary are procedures for the identification and documentation of relationships and interactions significant to the Stability and Support decision making environment. Perhaps more importantly, MA procedures and products must provide means to logically relate actions-effects-end states. Current doctrine, though adequately developed to act as a standard technique for application against Offensive and Defensive problem types, does not meet the requirements of the Stability and Support problem type. Specifically, MA doctrine does not provide for the procedure, techniques nor conceptual tools that will enable planners to fully explore and represent the complexity of the Stability and Support operational problem to the degree necessary to serve as a useful and effective tool for decision-making.

SYSTEMS THEORY TECHNIQUES AND PROCEDURES

Systems Theory Applied to Complex Problem Environments

Complex operational and decision environments are not unique to the military. Politics, sociology, and biology all offer examples of both detailed and dynamic complex situations. Common among those disciplines is the fact that interactions and reactions do not occur in isolation. In the real world, groups of people or animals do not interact without regard or

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[35] Ibid., 6-2.

influence from external forces; on the contrary, they are all part of a larger picture that both influences and is influenced by them. Cases where entities actively interact with the environment are known as open systems. Practitioners in several disciplines have developed problem solving methodologies designed specifically to deal with complexity within open systems that are potentially useful to the military problem solver. Of particular potential is the work done thus far in the area of general systems theory and several sub-disciplines of the relatively new science.

Systems Theory Background

Biologist Ludwig von Bertalanffy first proposed systems theory in a 1937 philosophy seminar.[37] Bertalanffy derived the concept of general systems theory from the observation that science was both moving towards increasing specialties and sub-specialization while across disciplines, similar "problems and conceptions" existed.[38] In physics, biology, psychology and the social sciences the focus of analysis was the determination of the elemental parts and their partial relationships– the breaking down of a problem to constituent parts to better understand the whole. Bertalanffy recognized though that across the sciences there remained a need to not only study parts and partial interactions looked at in isolation, but to also "solve the decisive problems found in the organization and order unifying them, resulting from dynamic interaction of parts, and making the behavior of parts different when studied in isolation or within the whole."[39]

The basic unit of study in general systems theory is the system, described by Bertalanffy as "organized complexity".[40] The word system has several accepted definitions. Webster's Dictionary defines the word as both:

> 1. A group of interacting, interrelated, or interdependent elements forming or regarded as forming a collective entity.
>
> 2. A functionally related group of elements.

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[36] Headquarters, Department of the Army, *FM 101-5*, 5-7.
[37] Ludwig von Bertalanffy, *General System Theory,* (New York, NY: George Braziller, 1969), 90.
[38] Ibid., 30.
[39] Ibid., 31.

There is a distinction, important to systems theory, between the definitions. The first is oriented on an emergent, physical entity, something that is tangible (e.g. an army). The second definition recognizes a system based upon function, something not tangible (e.g. targeting). Systems theory focuses on functional definition and the study of components that work together for the overall objective of the whole. Focus on function is a deliberate means to distinguish and model processes, patterns and relationships from events and things. Normally systems are thought of in terms of organizational structures and hierarchies. The focus of systems theory on purpose in defining what constitutes systemic structure significantly broadens the scope of what variables really are at play for any given problem. What constitute structure in systems analysis are the patterns of relationships among variables and subsystems.

As the result of the focus of general systems theory on interactions and relationships, it is a holistic approach to solving problems that are of an organized, complex nature. There is a distinct difference between a systems approach to problem solving and a more conventional analytic approach. Whereas classical problem solving involves analysts breaking a problem down into constituent parts and identifying individual, isolated causal chains, general systems techniques give definition to organization and wholeness as defined by the interaction of elements and processes.[41] When applied to human systems such as military operations, a system is characterized in terms of not only hierarchal structure, but also emergent properties like communication and control.[42] The general systems approach argues that the whole is not the sum of its parts, but instead the system can only be explained as a totality. Fundamental to general systems theory and thinking is the recognition that "in studying solutions to any problem, the whole is the primary consideration; its parts are only secondary."[43] The theory argues that all parts of any system act in accordance with the purpose for which the whole system exists. In

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[40] Ibid., 19.
[41] Ibid., 35.
[42] Checkland, *Systems Thinking, Systems Practice,* 318.

effect, it is the aim and purpose for the system that is most important to determining how individual parts or sub-systems will behave. Likewise, the effects of behavior of individual part or sub-systems are not independent of the entire system, and therefore no parts or sub-systems can be acted upon without affecting all other parts. The start point for any application of systems technique and procedure begins with an understanding of the aims and purpose of the "whole" as "all parts of the whole – and their relationships to one another-evolve from this."[44]

Relevant Systems Theory Methodologies

Bertalanffy, in his writings on systems theory, called for the creation of new conceptual tools necessary to examine the interaction of large numbers of variables. Practitioners and theorists in multiple fields have since developed systems theory into several distinct methodologies as well as practiced techniques. The field of systems theory now includes multiple disciplines such as cybernetics, complexity theory, chaos theory, operations research, as well as hard and soft systems methodologies. Despite the breadth of work in the field, there is yet to be produced any one approach that is universally applicable to all problem types. Instead, the pattern is for the theory to be useful in development of conceptual and empirical tools for specific problem areas – thus the development and application of operations research and systems analysis to certain problem areas in both business and military operations. Despite the lack of a systems Rosetta stone, there are several divergent yet equally well developed methodologies that have had considerable success in business and social / governmental applications and represent potential tools for decision support in the SS operational environment.

General Systems Theory

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[43] Stephen G. Haines, *The Complete Guide to Systems Thinking and Learning,* (Amherst, MA: HRD Press, 2000), 7.
[44] Ibid., 6.

Under the category of general systems theory is the work done by Stephen G. Haines of the Center for Strategic Management. Haines work is classified as general systems theory because it draws heavily on the early work of Bertalanffy and other biologists in drawing systems insight from the biological sciences. At the heart of Haines' work is the identification of concepts, based on natural laws that comprise his "systems thinking approach"[45]

Concept 1: There are seven levels of living (open) systems

Concept 2: There are twelve laws of natural systems

Concept 3: The input, throughput, output, feedback model represents how living systems naturally operate

Haines work is itself an amalgam of work done by multiple people and organizations from across disciplines. It is of primary value in further defining what a system is – and is not.

The seven levels of open systems has direct lineage to the biological sciences (Appendix B-1). The concept recognizes seven levels at which there emerge distinct and sustainable organizational structure. Biologically the stages range from cells to super national systems such as a continent. Of particular interest to Haines work are open systems ranging from single organism, through organizations, to society. Haines notes that every open system exists within a hierarchy, interacting with and affected directly by the emergent systems immediately above and below.[46] Knowledge of what level system and what interactions exist with higher and lower systems is critical to the prediction of second and third order effects of any action taken at any level. The concept is fundamental to systems thinking in that it demonstrates the existence of systems within systems and forms the basis for the conceptualization of complex dynamic structures.

[45] Ibid., Preface.
[46] Ibid., 14.

Haines' second concept is detailed in his book, *Introduction to Systems Thinking and Learning* as "laws of natural systems" or "standard systems dynamics".[47] The laws, reproduced in Appendix B-2, represent characteristics present in all living systems as defined in his first systems concept. The significance of the dynamics is to problem definition. To define a system at any level of organization, all of the dynamics must be taken into account. Concept 1 provides a conceptual basis for defining structure; concept 2 provides the basis for defining how the system behaves. Haines groups the dynamics into two categories, those dynamics that describe the systems as a whole and those that describe the internal workings of a system.

Haines third concept with potential relevance to STABILITY AND SUPPORT operations is the input-throughput-output-feedback model for systems (Appendix B-3). The model, in one form or another is common throughout systems and problem solving methodologies and is often referred to as a OODA loop. Unlike his other two concepts, the A-B-C-D model is not always present in living systems – at least at a tangible level. Instead, it is a representation of a mental model or mind-set that is fundamental to a systems approach to problem solving – namely beginning any endeavor with a clear understanding of the end state. Note the orientation of A-B-C-D within the model. Emphasis is placed on first identifying the future or goal, then determining feedback to indicate when the goal is or is not being achieved prior to analysis of current state and potential ways for achieving the desired output.

From his basic concepts, including one additional concept relative to system life cycles not discussed here, Haines developed sixty-four tools to apply his concepts to complex organizational problems in business.[48] Of particular interest and relevance are those tools that directly map to activities that occur in mission analysis, namely, determination of current conditions, desired end state and feedback mechanisms. Haines devotes several chapters to detailing tools specific to these areas. Chapter two of the book details the application of standard

[47] Ibid., 15.
[48] Ibid., ix.

systems dynamics (Appendix B-4). These tools specifically address thirteen questions that are asked in the early stages of problem solving in order to fully define a problem before the determination of ways to solve the problem.

Hard Systems Theory

Under the category of hard systems theory is the work done by Peter Senge and detailed in his books *The Fifth Discipline* and *The Fifth Discipline Fieldbook.* Senge's work is based upon understanding how complex feedback processes influence behavior within organizations. Senge stresses systemic structure as defined previously – factors beyond hierarchical structure determined by how entities within the problem environment interact. Senge defines systemic structure as something that is "built out of the choices people make consciously or unconsciously, over time."[49] Senge identifies systems thinking as an integral part of his overall philosophy for building successful organizations that he organizes into five disciplines. Systems thinking though is in his words the, "conceptual cornerstone that underlies all of the five learning disciplines of [his] book. All are concerned with a shift from seeing parts to seeing wholes."[50] Conceptually, Senge provides several tools that offer potential for application to the SS operational problem-solving environment: Links and loops, archetypes, and stack and flow modeling.

Links and loops are a means to assist with identifying and graphically represent relationships between and among entities within a problem environment. Senge identifies that we as individuals and organizations often see the world linearly, as straight lines of cause and effect. Reality though is nonlinear; it is "circles of influence".[51] Feedback loops are what cause circles of interaction. Contrary to linear action – reaction thinking, feedback theory recognizes that every input is also an output for some other systems within an open system. Often the causal links come

[49] Peter Senge, Art Kleiner, Charlotte Roberts, Richard Ross, and Bryan Smith, *The Fifth Discipline Fieldbook: Strategies and Tools for Building a learning organization.* (New York, NY: 1994) 90.
[50] Peter M. Senge, *The Fifth Discipline: The Art and Practice of The Learning Organization,* (New York, NY: Doubleday, 1990), 69.
[51] Ibid., 75.

back either directly or indirectly to the system of origin forming what Senge terms a loop. In Senge's methodology, the key to getting beyond seeing just things and events is by tracing influence through a system – by mapping links and loops. Links and loops then form the basis for conceptual tools to identify patterns within a given problem environment. Appendix C-1 provides an example from *The Fifth Discipline Fieldbook* of a simple feedback loop in which it is demonstrated how outpatient occupancy is looked at from a systems perspective – a cycle of inputs, outputs, feedback oriented towards a goal. Patterns identified through diagramming feedback loops define the systemic structure of a problem.

There are several fundamentals within Senge's links and loops concept that exist throughout different systems methodologies. The first point is again the primacy of systems as defined by something other than organizational hierarchy. In developing loops, Senge prescribes a verb-noun methodology to specify the objects linked within a given loop. The methodology provides for visualization of not only what physical entities within the system are effected, but also notes measures, or feedback, that are significant to the function the entity performs. Also important to the concepts of both general and hard system theory is that Senge identifies a target or goal that the system is working to achieve. Goal directed behavior provides the means by which measures of effectiveness are determined. A key concept noted by Senge though is that some goals may be unknown by elements within the system. Haines also noted that natural systems might have multiple competing goals. The fascinating point is that the patterns developed through link and loop diagramming may in fact point out previously unknown or unrealized goals. Despite the specified goal for any given system, the systemic structure may itself bound the behavior of the system, establishing an unspecified goal counter to what the system is intended to achieve. Such behavior parallels the concept of the attractor in complexity/chaos theory. Noted in certain complex systems was the tendency for actions to move towards or about a point in space-time – within the chaotic system at some level was the drive towards what is termed an attractor.[52] Systemic structure is similar to an attractor in that it can define the constraints on the behavior of a system.

Senge takes the concept of feedback loops further by identifying what he calls system archetypes. Building upon the basic, early concepts of system thinking, Senge identifies that behavioral patterns or systemic structure reoccur in the real world. These reoccurring patterns are termed "system archetypes" and serve as powerful tools for determining where action needs to be taken in order to implement long-term solutions to current problems. In a very real sense, Senge offers a mechanism for simplistically portraying dynamically complex problems. As with the Lorenz equations discussed previously, seeing the structure or archetype(s) does not in and of itself solve any problem, but structural knowledge inherent to the archetype bounds the problem and the range of feasible and suitable solutions. Appendix C-2 details the relationships among the complete set of archetypes identified by Senge.

Of note for each archetype are ways in which leverage can be gained. The concept of leverage is similar to both the Army concept of the decisive point and the Joint term leverage. Senge defines leverage points as, "small, well focused actions" that can produce "significant, enduring improvements."[53] As with military decisive points, the art is in finding where those points are. A systems theory principle common to both Senge and Haines is the dislocation of root cause from effect in time and often space, meaning that the "obvious solution" probably is not the long term solution to the real imbalance in the system. Identification of leverage then depends upon clearly and accurately defining the system structure in order to identify patterns of behavior. It is in the patterns that high-leverage changes in human (open) systems can be identified.[54]

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[52] Gleick, *Chaos,* 28.
[53] Senge, *The Fifth Discipline: The Art and Practice of The Learning Organization,* 64.
[54] Ibid., 65.

Soft Systems Theory

Soft systems theory is a substantive departure from the general and hard systems approaches discussed thus far. In both hard and general systems theory there is the assumption that the system of systems has a defined goal or end state. The soft systems approach as developed by Peter Checkland instead recognizes that often in reality individuals and organizations are confronted by problems where the aim or goal in either undefined or at best only vaguely formulated. The soft systems approach is one of systemic inquiry, designed to explore and define what is perceived to be complex, even chaotic behavior of real-world systems – primarily human, social systems.

Soft systems engineering recognizes that in vague problem situations, "no systems hierarchy relevant to the problem [can] be taken as given."[55] The concept is important given the assumption that people and organizations normally default to a linear and hierarchical view of the world. Checkland identifies that any definition of a system is dependent upon viewpoint. From a functional perspective how a system operates and what is significant to the system can vary greatly depending upon where within the system attempts are being made to represent or model what is happening. Checkland realized from this that central to any attempt to solve a perceived problem is to create an explicit viewpoint from which systemic cause and effect can be examined.[56]

Using the central idea of viewpoint or perspective, Checkland developed what he calls the soft system methodology, a seven-stage framework for problem solving based on systems theory (Appendix D). The soft system methodology is a complete, alternative problem solving methodology. The methodology takes the practitioner from defining the problem and situation, to development and evaluation of potential courses of action, through selection of feasible and desirable changes to the system(s). As such, the methodology has several stages that go beyond

[55] Checkland, *Systems Thinking, Systems Practice,* 160.
[56] Ibid.

the scope of mission analysis and this monograph. Potentially relevant though are stages one through four, which roughly equate to mission analysis in the military decision making process.

Stages one and two of the process are labeled "the problem situation unstructured" and "the problem situation expressed" respectively.[57] Collectively the stages represent an attempt to develop as complete as possible a picture of the situation. Stage one focuses on identification of elements or variables significant to the problem. Checkland's research indicates that the stage is best fulfilled when there is complete definition of all "slow to change structure" as well as "continuously changing process".[58] Stage two, expression, then involves making determinations as to how structure and process relate. As noted in previous systems methodologies, Relationships among entities and processes define systemic structure. Attention is paid not to defining the problem during this stage, but rather to focus on the systemic structure that has the potential to bear upon problem solution(s). Given the preeminence of perspective, stage two will in most cases end with multiple views of the system or systems potentially relevant to the problem environment that are subject to engineering.

Stage three begins that part of the methodology that Checkland characterizes as systems thinking. Labeled "root definitions of relevant systems," stage three is still part of problem definition with the purpose to identify and name systems that have the potential to be significant to the problem environment. System naming in this stage is done in terms of what the systems are as opposed to what they do. This is consistent with other systems methodologies in that the focus is on function, without emphasis on existing structure, hierarchy or processes. An example from one of Checkland's case studies defined a real world social services department as,

> A department to employ social workers and associated staff to build and maintain residential and other treatment facilities and to control and develop the use of these resources so that those social and physical needs of the deprived sections of the community which Government statute determines or allows, to the extent to which County Council, as guided by its

[57] Ibid., 165.
[58] Ibid., 164.

> professional advisers, decides is appropriate, are met within the annual capital and revenue constraints imposed by the Government and Council.[59]

Such a definition commits to a particular view of the system within the problem situation and serves as the root or basis upon which all further analysis orients. A characteristic of root definitions is that their usefulness is proportional to their explicitness. Checkland's work suggests that root definitions should incorporate as many constraints as deemed necessary to fully define the nature of the system in its environment. Explicit definitions ensure that everyone involved with the analysis process has the same perspective, as well as assist with model development in subsequent stages.[60]

Stage four is labeled "Conceptual model(s)" and involves the construction of models to represent the root systems defined in stage three. Checkland identifies this stage as both the conceptually most difficult as well as the most important to the soft systems methodology. The purpose of this stage is to define a nominal system capable of accomplishing the root definition(s) established in stage three. The difficulty in this stage is the tendency for practitioners to default to the system as defined in reality. The goal though is to construct a conceptual model that is not bound or constrained by how things are currently done. The intended benefit is the production of what could be considered as "out of the box" solutions to systemic problems. The methodology is very similar to IDEF methodology for functional modeling developed by the U.S. Air Force in the 1970's. As with IDEF, the technique is to rigorously define the components of the system such that the model enables questioning of the system so that the answers reveal inadequacies in the model or the root definition for the system.[61]

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[59] Ibid., 168.
[60] Ibid., 168.
[61] Ibid., 176.

Applicability of Systems Theory to Stability and Support Operations

Mission Analysis

Systems techniques and methodologies offer the basis for a complimentary process for accomplishing the purpose of military mission analysis – allow the commander to begin battlefield visualization and define the problem in order to begin the process of determining feasible solutions.[62] Obvious concerning the divergent systems practices presented is the fact that every one of them was developed for and applied to problem environments other than military operations other than war. Important to keep in mind though is that the detailed complexity, dynamics and end states may be different from the Stability and Support operational environment, the type of problem that the techniques were developed for are consistent among the case studies and the Stability and Support operational environment – namely problem environments exhibiting both detailed and dynamic complexity. At question is whether the systems techniques meet the identified shortfalls in current MA doctrine for Stability and Support operations and how the techniques can be modified to the military decision making process

Comparison of Current Doctrinal Shortfalls and Systems Theory Potential

As established in chapter one, Stability and Support operations fundamentally and quantitatively differ from Offensive and Defensive operations with respect to the complexity and operational aim. The dynamic effect is to create a problem type that is significantly different from that in Offensive and Defensive operations and that requires problem-solving tools beyond the scope of the current military mission analysis and intelligence preparation of the battlefield processes. Current doctrine lacks a process to identify and document relationships and interactions significant to the Stability and Support decision-making environment as well as a means to logically relate actions-effects-end states in ambiguous planning environments. Required are a process and techniques that will enable commanders and staffs to fully explore and represent the complexity of the Stability and Support operational problem to the degree necessary to serve as a useful and effective tool for decision making. Although each of the systems techniques presented are represented by their authors as stand alone applications of systems theory offering the means to solve complex problems, none of the techniques is obviously, directly transferable to the military decision making process. Each technique though does provide insight and addresses shortfalls identified in current mission analysis and intelligence preparation of the battlefield doctrine.

The first shortfall of current doctrine is how it responds to the perceived complexity of Stability and Support operations. Although current doctrine for mission analysis in stability and support environments correctly identifies the need for collection of more and different information significant to the problem environment, the doctrine falls short in detailing ways, other than through intuition, for determining why and how the information is relevant. Each of the systems techniques provides new types of detailed information that contribute to defining the problem environment. With systems theory though, the explicit information requirements are not ends in themselves but rather directly contribute to the development of information not explicit in current doctrine – systemic structure. By redefining the problem environment in terms of interacting systems with a definable systemic structure, systems theory gives direction, consistency and purpose to additional information requirements in Stability and Support operations.

The nature of dynamic complexity in Stability and Support operations is the second shortfall of current doctrine addressed by systems theory. Current doctrine goes along way towards defining the dynamic complexity of the conventional, Offensive and Defensive operational environment. As noted earlier, commanders and staffs do not have to rediscover in every operation the significance of the relationship of key variables such as firepower and leadership to combat power. The U.S. Army's institutional efforts studying and relating history

[62] Headquarters, Department of the Army, *FM 101-5,* 5-5.

and theory has reduced the uncertainty of the significant relationships among variables in Offensive and Defensive operations. The same cannot be said though for Stability and Support operations. Systemic structure as defined by the systems theorists is in fact a means for exploring and documenting the relationships of variables. In a very real sense the systems techniques offer the potential to identify causality and patterns in the Stability and Support operational environment. The ability to define systems within the operational environment, understand principles for how the systems behave, and document how systems interact allows for the realization of potential second and third order effects - effects that otherwise would not be made explicit to the commander and staff.

The systems techniques discussed provide new methods for graphically representing complex systemic structure. Current U.S. Army IPB doctrine has very well developed tools such as event and situation templates to graphically represent complex relationships such as the development of enemy courses of action overtime.[63] Similar in concept are hard and soft systems techniques such as Senge's links and loops and Checkland's problem expression methodology. Systems graphical tools may provide a means for commanders and staffs to represent, develop, and distribute complex concepts for systemic structure, greatly simplifying what could otherwise be exhaustive narratives. Such models represent potentially valuable tools to develop common mental models within military organizations as well as a potential means to effectively communicate ideas to and with non-military organizations. Both the hard and soft systems techniques provide graphical examples with potential for adaptation to the military problem-solving environment.

Indirectly the systems techniques could help redirect and focus the identification of commander's critical information requirements. The systems theories presented provide detailed procedures and requirements to fully define the systems interacting within a given problem environment. Given the dominance of dynamic complexity in the Stability and Support operational environment, such information requirements are essential to the commander and staff in accurately visualizing the battlespace. The need to fill holes in a model of the systemic structure of a problem could then have the potential to offer new direction and definition to critical information requirements.

Requirements for Systems Theory Doctrine

Given the suitability of systems theory to address identified shortfalls in U.S. Army mission analysis doctrine with respect to Stability and Support operations, still at question are the feasibility and acceptability of integrating systems techniques into mission analysis doctrine. No matter the theoretical usefulness of systems techniques, systems theory indicates that there are constraints, variables, and relationships associated with the current military decision making process that will influence and perhaps determine the feasibility and acceptability of integrating systems thinking techniques. A rudimentary analysis of the military decision making process as a system readily indicates that any changes imparted to the process will influence other significant U.S. Army systems such as training, organization, personnel, and operations – indicating potential for second and third order effects not self evident given the intended purpose of systems tactics, techniques and procedures (TTP) (Appendix E). With the systemic nature of the current U.S. Army process for conducting mission analysis in mind, several conditions must be meet in order to maximize the potential for successful integration of systems techniques into U.S. Army doctrine.

- Systems TTP must work within the existing MDMP and Joint planning process. Both the U.S. Army MDMP and the Joint planning process represent integrated models for rational decision-making. Both models are integrated in the sense that they have mature, developed interfaces with other significant systems in the military (e.g. institutional programs of instruction, planning timelines, information collection and exchange requirements, organizational products,

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[63] Headquarters, Department of the Army, *FM 34-130,* 3-33 – 3-27.

etc). Both processes are not isolated processes, but are, consistent with systems theory, integrated with many other systems that comprise the military. Given the complex nature of the interrelation of major systems such as training and decision-making, any addition to current mission analysis doctrine must be integrated to not disrupt the existing system balance. As noted, current MDMP is a valuable tool does not require replacement, but rather augmentation, with as much attention as possible to leveraging the systemic structure currently in place.

Systems TTP must be applicable in real operational environments to include time sensitive situations. Common to every one of the systems studies done by the authors addressed herein is the fact that none of studies was done in an operating environment comparable to those that the military characteristically operates in. Not withstanding the potential for harsh environmental conditions, the military planning environment is subject to other, less neutral constraints. A primary consideration for the feasibility of any systems TTP will be sensitivity to the effects of severe time constraints. The systems studies done using techniques recognized here in were done on time scales ranging from weeks to several months[64]. The norm for U.S. forces participating in Stability and Support operations is to have stringent time constraints often restricted to hours or days (e.g. U.S. forces responding in 1994 to the humanitarian crisis in Rwanda established an operational Civilian Military Operations Center in Goma, Zaire one week after notification of the mission by the national command authority).[65] Given the hierarchical nature of military command structure, time available for planning becomes even more constrained for subordinate levels of command as they typically plan with a fraction of the time provided to the immediately higher command. Any military systems doctrine and TTP must therefore account for time constraints.

Systems TTP must work within existing personnel authorizations and should not require a trained systems engineer or facilitator. Another trait common among the systems references

[64] Checkland, *Systems Thinking, Systems Practice,* 194-213.

written about thus far is the fact that trained systems engineers either facilitated or conducted the studies in which systems techniques were successfully applied to a problem. It is reasonable to assume that there is little probability of the Army rewriting personnel authorizations for all commands to include school trained systems engineers capable of implementing systems doctrine. Given this, any systems TTP must be actionable by existing command and staff structures. There will obviously need to be some requirement for education and training on the techniques, but military systems TTP must be developed and structured to permit training to a functional standard within the current institutional and unit training horizons and given the predominate education level of commanders and staffs expected to execute it.

Systems TTP should be a methodology that guides commanders and staffs in the collection, analysis and synthesis of information that will be useful for problem solving. In this regard, systems TTP should provide clear linkage among what is collected, how the information is processed and where within the basic model for problem solving (i.e. objective, feedback, means, ways) the processed information is applicable. Systems TTP must not be laundry lists of facts to collect, but rather a methodology for focusing mission analysis efforts in directions appropriate to the Stability and Support problem type. The result should provide commanders and staffs with the information necessary to determine feasible courses of action.

Systems doctrine must have doctrinally recognized terms and definitions. By necessity, there will be new terms associated with the process of systems TTP. All terms must be clearly defined in order to reduce any ambiguity and resulting, unnecessary complication of the systems theory TTP.

APPLICATION OF SYSTEMS THEORY TO MISSION ANALYSIS

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[65] Chris Seiple, *The U.S. Military/NGO relationship in Humanitarian Interventions,* (US Army War College, PA: Peacekeeping Institute, 1996), 143 & 148.

Proposed Systems Theory TTP

The goal for systems theory doctrine is to synthesize and represent relevant information to the commander to allow him to begin his battlefield visualization. Consistent with the requirements detailed in FM 101-5, the outcome of systems theory doctrine for mission analysis is to define the operational environment and set conditions for the determination of feasible courses of action. The following sections of the monograph will detail a notional systems theory model for achieving that specified goal and outcome. The notional systems theory model is conceptual and details the inputs, activities and output for systems theory TTP unconstrained by the current mission analysis doctrinal process.

The notional systems mission analysis model is graphically presented in the appendices using the IDEF 0 functional modeling methodology that is a tool for representing hierarchical processes.[66] The graphics of the methodology are rectangular boxes and multidirectional arrows. Boxes in the methodology represent activities or functions performed in the process and defined as verb-noun phrases. As a rule, activities are functionally grouped such that only from three to eight activities appear on any one page of the model. Every activity box is capable of being decomposed into finer levels of detail, each of which is constrained to three to eight subordinate activity boxes. For clarity, each level of decomposition within the model is represented on a separate page. Arrows are used to represent inputs, outputs, controls and mechanisms within the process. Where an arrow physically interfaces with an activity box indicates what the arrow represents. Arrows entering the left side of a box represent inputs, arrows exiting the right side of a box represent output, arrows entering the top of a box represent controls, and arrows entering the bottom of a box represent mechanism. Inputs and outputs are self-explanatory. Controls represent constraints to the activity represented in the box (e.g. a regulation). Mechanisms represent the means by which the activity is performed (e.g. a computer).

Notional Systems Theory TTP

In order for systems mission analysis to successfully set conditions for the commander to both visualize the operational environment and begin to determine feasible courses of action, the process must address three basic components of problem solving: determination of goals and objectives, measures of effectiveness, and situational understanding (ends, measures, means respectively). The output of systems mission analysis doctrine is three fold: definition of the complex, SS operational environment through conceptual models that can serve as the basis for determining feasible courses of action; quantifiable feedback mechanisms that serve as uncomplicated measures of effectiveness to indicate the need for decisions; a mechanism for the identification of possible actions and objectives in situations with undefined or ambiguous planning guidance.

Appendix F contains a functional model of the notional systems mission analysis process. The appendix and functional diagram number referenced in each part of the narrative precede subsequent paragraphs. Systems mission analysis is a seven-step process that provides multiple tools to assist commanders and staffs with battlefield visualization. As a functional model, the steps do not necessarily represent sequential activity. The seven-step process for systems mission analysis is:

1. Analyze the OPORD
2. Define the Systemic Structure
3. Analyze Assigned Tasks
4. Determine Problem Bounds
5. Develop Conceptual Model(s)
6. Develop Guidance
7. Determine Measures of Effectiveness

Each of the seven steps has multiple sub-tasks.

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[66] U.S. Department of Commerce, *Federal Information Processing Standards Publication 183.* (National Institute for Standards and Technology, Gaithersburg, MD: National Institute for Standards and Technology, 1994), 46-48.

Analyze Higher Operations Order

(Appendix F-1, MA1) Analyze OPORD represents the first critical step in the systems mission analysis process. The purpose of the Analyze Order step is to ensure that both commanders and the staff understand the relationships of higher and adjacent unit missions, tasks, and purposes with respect to time and space. The primary input to this step of the operation is the higher level operations order (OPORD) or operations plan (OPLAN) but can also include Fragmentary Orders (FRAGO), Warning Orders (WARNORD) and adjacent unit products. The primary outputs of the analyze the order step are a timeline for conducting the remainder of the mission analysis, a nesting diagram detailing the relationships among higher and adjacent unit missions, tasks, and purposes, and the identification of the battlespace components. The Analyze OPORD step includes six subordinate functions: understand the higher commander's intent, understand the higher headquarters' mission, understand the higher headquarters' concept of operation, diagram task and purpose relationships, determine time constraints and determine the battlespace components.

The systems tool that facilitates the understanding of task and purpose relationships in this step is the nesting diagram (Figure 1). The nesting diagram graphically represents the hierarchical order of tasks and purposes among the units specified in the OPORD with respect to time. The diagram ensures that commanders and staffs have a common understanding for both which actions within the unit are dependent upon other actions (represented by solid arrows) as well as where actions influence other actions without there being dependency (represented by dashed arrows).

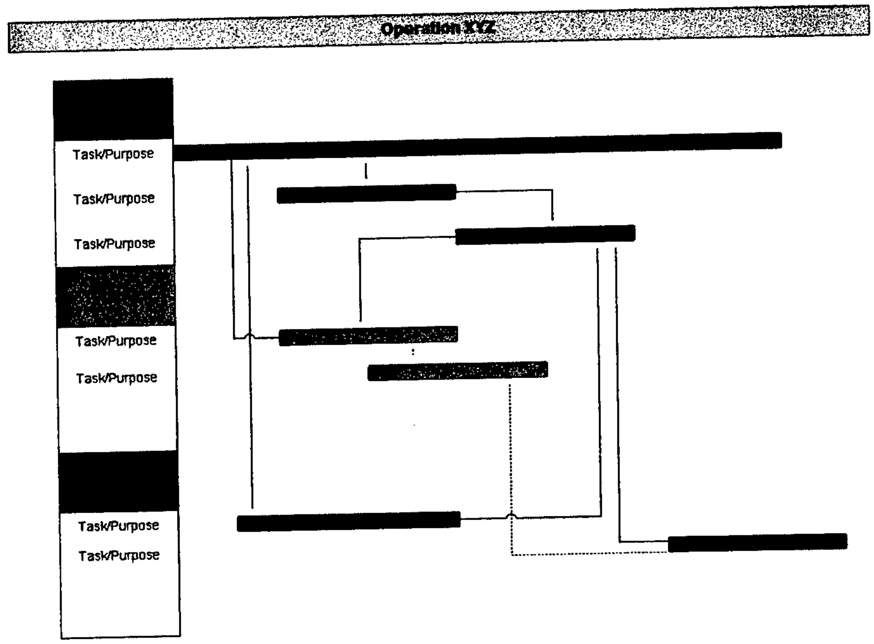

Figure 1: Nesting Diagram

Dependency indicates a hard requirement that a given task and purpose be accomplished before another task and purpose can be started. Influence indicates a situation where the effects resulting from one task and purpose can have some impact on the conduct of another task and purpose without either being a prerequisite for the other.

Other important outputs from the Analyze OPORD phase of systems mission analysis are determination of information requirements (IR), the planning timeline, and the battlespace components. Inconsistent with current doctrine, information requirements as defined in this phase of mission analysis are expanded to account for information regarding friendly forces that must be collected and processed in order to meet the commander's visualization and situational understanding needs.[67] Also important to visualization and later the bounding of the problem is the determination of the battlespace components defined as the Area of Operations (AO), Area of Influence (AINF) and Area of Interest (AINT). All three concepts are consistent with current doctrine in that they define the physical area designated for operations, the area which the commander can directly influence through maneuvers, information, and/or fires, and the area of

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[67] Headquarters, Department of the Army, *FM 101-5-1,* 1-82.

interest to the commander for its potential to influence operations respectively.[68] The final significant output from the Analyze OPORD phase is development of the planning timeline, which constrains not only the remaining phases of mission analysis but also allocates the available planning time among the remaining steps of the military decision making process.

Define Systemic Structure

(Appendix F-2, MA2) Define Systemic Structure is the second step of the systems mission analysis process and is the first step that is pure application of systems techniques. The purpose of defining systemic structure is to develop as complete a picture as possible of the situation, defined as the relationship between structure and process. Primary inputs for the step include the operations order and answers to information requirements. Primary outputs of the activity are requests for information, information requirements, a model of the existing systemic structure within the battlespace components, and estimates of the center(s) of gravity. The activity consists of three subordinate actions, define the situation structures, define the situation processes, and relate structures to processes. Collectively, the tools and products of the steps within the define systemic structure phase are potentially very powerful in assisting the commander in visualizing the situation, possible goals and objectives, and feasible courses of action.

Defining the situation structure entails information collection, processing, and representation of information on all of the physical systems and human organizations capable of influencing the problem situation and the determination of how they physically relate to each other and the battlespace components. The systems tools that come into play in this step are the concept of the natural hierarchy of systems and influence diagramming. Determination of physical systems entails both identification of and thorough definition of closed systems that bear on the problem situation. Closed, physical systems range from transportation networks,

[68] Headquarters, Department of the Army, *FM 3-0,* 4-19 thru 4-21.

communications and power grids, to natural systems such as complex terrain, hydrology and weather. Wherever possible, information collected and analysis on physical systems is represented graphically on maps. Analysis focuses on identification of physical locations that permit the influence of one or more physical systems.

Defining the human organizations capable of influencing the problem situation entails collecting information on all of the human systems operating in the AO, AINF and AINT that the staff determines to be potentially relevant to the problem. General systems theory and specifically the characteristics of open systems shapes the information collected and represented for each of the organizations operating within the battlespace. Modeling the human organizations requires diagramming at several levels to include hierarchies within a given organization and hierarchies among organizations. Each organization is first diagramed in isolation along its internal hierarchical structure (Figure 2).

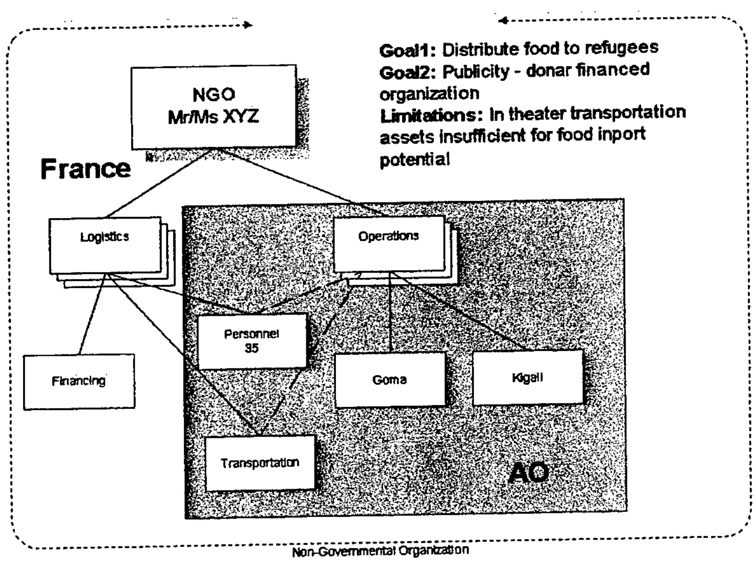

Figure 2: Organizational Hierarchy

The purpose for this level of modeling is to develop as rich an understanding as possible of the organization, personnel, and means available to the systems that will be interacting throughout the course of the mission. The stage will result in requests for information and possibly information requirements that are both external to the U.S. military and not threat oriented, which establishes the requirement for the expansion of the doctrinal definition of information requirement. Planners during this step must also determine where within the battlespace components elements of the identified organizations reside. Mapping the organizations against the battlespace provides the staff with early indications of potential liaison, communications requirements, and limitations.

In addition to understanding the physical structure of human organizations operating within the battlespace components, the staff must also define the organizations in terms of the characteristics of open systems to include goals, system bounds, and feedback mechanisms. Of primary importance is the determination of what goal or goals orient the actions of the organization. As noted by Haines, all human systems are goal-seeking and most organizations have multiple goals. The staff must also attempt to identify the boundaries affecting each of the organizations. Boundary conditions include constraints, restrictions, limitations, mechanisms and possibly assumptions that define how the organization interacts within the battlespace components. Feedback is the information that the organization collects in order to regulate its' performance with respect to its goals. Admittedly difficult, the identification of feedback mechanisms provides valuable insight into decision making of organizations and therefore the potential to anticipate behavior of the organization.

Information management is important to this step of systems technique. Wherever possible systems mission analysis emphasizes representing information graphically, with the full realization that not all relevant information will organize logically within a given graphical tool. Additionally, there will remain the need to be able to reference source data used in model development. There is therefore a need for the storage of, and the ability to access the potentially large volume of information that will result from model development and the execution of associated information requirements. Information collected on organizations and physical systems should be stored in individual files labeled collectively as systems folders- preferably using an automated database to permit more efficient information processing and retrieval given large amounts of data.

As the mosaic of organizations builds, they are collectively diagramed indicating the relationships between and among organizations (Figure 3). In diagramming at this level, the focus is on representing at what levels and via what means organizations within the problem environment interact. As might be expected the diagramming is both continuous and evolutionary based upon organizational dynamics.

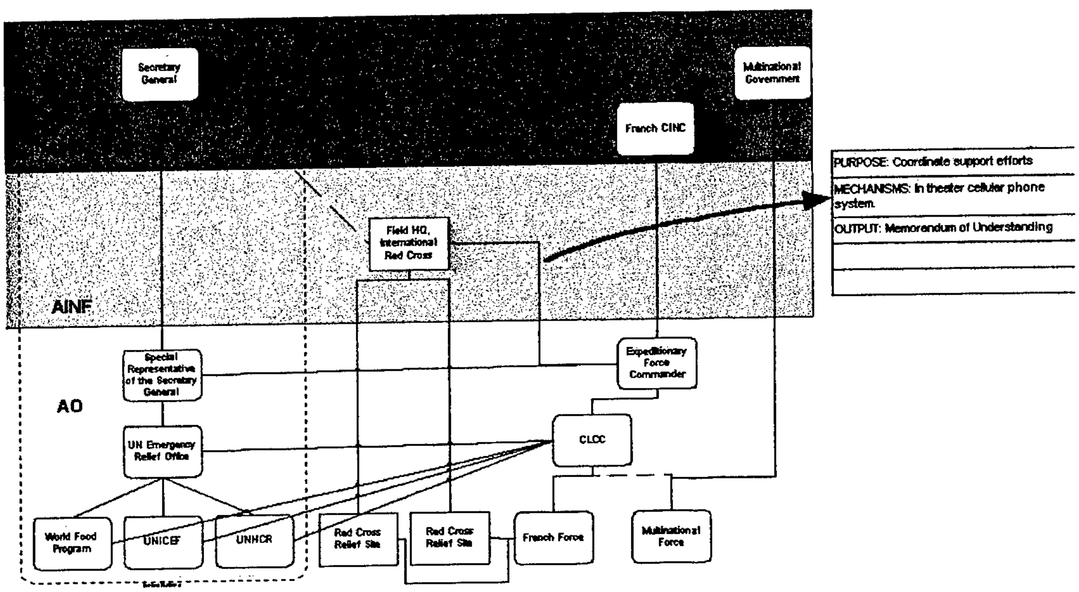

Figure 3: Organization Influence Diagram

For problem environments that are structurally simple – that is relatively few identified, relevant systems, planners can graphically portray all the relationships among all of the organizations. As the problem structure becomes more complicated, the need for clarity will require changes in technique to include representing organizations as single entities or minimizing representations of organization's internal hierarchies. An alternate technique is to model the system of systems from the perspective of each of the relevant systems. The relevant systems perspective allows for the representation of detailed organizational hierarchies and the representation of how organizational hierarchies interact. Whichever technique(s) adopted, the focus of this level of model is on the determination of how different organizations interact and for what purpose. Each line connecting levels of organization within the model represents an interaction.

Interactions are a significant part of defining the systemic structure of the problem environment. As such, the lines drawn on a given organizational influence diagram represent information or the need for information. Every interaction drawn graphically should define the relationship it represents as fully as possible and at a minimum include the purpose for interaction, the mechanisms used to interact, and what is exchanged (Figure 3). Actual techniques will vary depending on the modeling medium adopted, but the effect should be that each line is linked to a table of attributes that represent the known information in detail. Of the required interaction attributes, purpose for the interaction is the most important and in terms of prioritization of work should be done first for all known interactions. Purpose of interaction is a primary indicator of goal oriented process within the problem environment and thus serves as a tool to direct the second step of the Define Systemic Structure phase of systems mission analysis – Define Situation Processes.

As defined by Checkland, the systemic structure of any problem situation is the relationship of the physical structure of the interacting systems (the focus of the preceding paragraphs) to the processes at work in the environment. The second step of the Define Systemic Structure phase of systems mission analysis is to define the situation processes. Process for the purpose of systems mission analysis is defined as goal oriented behavior that transforms discrete inputs into discrete outputs via the application of mechanisms and subject to controls. The primary systems tool applicable to this step of systems mission analysis is Integration Definitions Modeling (IDEF). IDEF is a graphical methodology for representing hierarchical processes. The graphics of the methodology are rectangular boxes and multidirectional arrows. Boxes in the methodology represent activities or functions performed in the process and defined as verb-noun phrases. As a rule, activities are functionally grouped such that only from three to eight activities appear on any one page of the model. Every activity box is capable of being decomposed into finer levels of detail, each of which is constrained to three to eight subordinate activity boxes. For clarity, each level of decomposition within the model is represented on a separate page. Arrows are used to represent inputs, outputs, controls and mechanisms within the process. Where an arrow physically interfaces with an activity box indicates what the arrow represents. Arrows entering the left side of a box represent inputs, arrows exiting the right side of a box represent output, arrows entering the top of a box represent controls, and arrows entering the bottom of a box represent mechanism. Inputs and outputs are self-explanatory. Controls represent constraints to the activity represented in the box (e.g. a regulation). Mechanisms represent the means by which the activity is performed (e.g. a computer).[69]

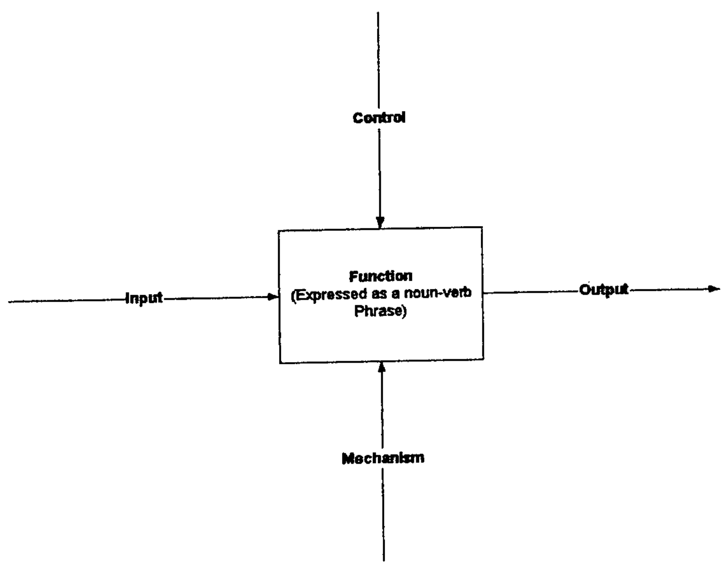

Figure 4: IDEF Symbology

As a technique, staff members responsible for defining system processes should begin by identifying as many potentially relevant processes as possible and recording those processes at the highest level of process decomposition – a single noun-verb phrase and any known inputs, controls, outputs, and mechanisms (ICOMs) (Figure 4). Given a number of potentially relevant processes, the staff then can prioritize individual processes for more detailed decomposition with respect to the perceived relevance of the process and available time.

[69] U.S. Department of Commerce, *Federal Information Processing Standards Publication 183,* 46-48.

Unlike conventional process diagramming, the intent is not to identify sequences or a chronology of tasks, but rather to identify and relate the functions or tasks that occur within the process. The IDEF methodology offers the staff great flexibility in that the hierarchical nature of the methodology allows for modeling at whatever level of understanding the staff has and to whatever level of detail the staff needs. The staff begins by defining a given process with between three and eight functions. For every function, the staff then defines the three to eight subordinate functions that comprise that specific higher-level task. The process of identifying finer and finer levels of subordinate functions is task decomposition (Figure 5). The staff determines what level of decomposition is both possible and necessary. Early in mission analysis, there in all probability will be more questions than answers as to processes active in the battlefield framework. Questions or gaps in knowledge of perceived relevant processes represent information requirements. Given constraints in time and resources for information collection and processing, the focus for process modeling in this step of systems mission analysis is identifying functions, inputs and outputs. Complete definition of controls and mechanisms will occur during the integration of process with structure in the final step of defining the systemic structure.

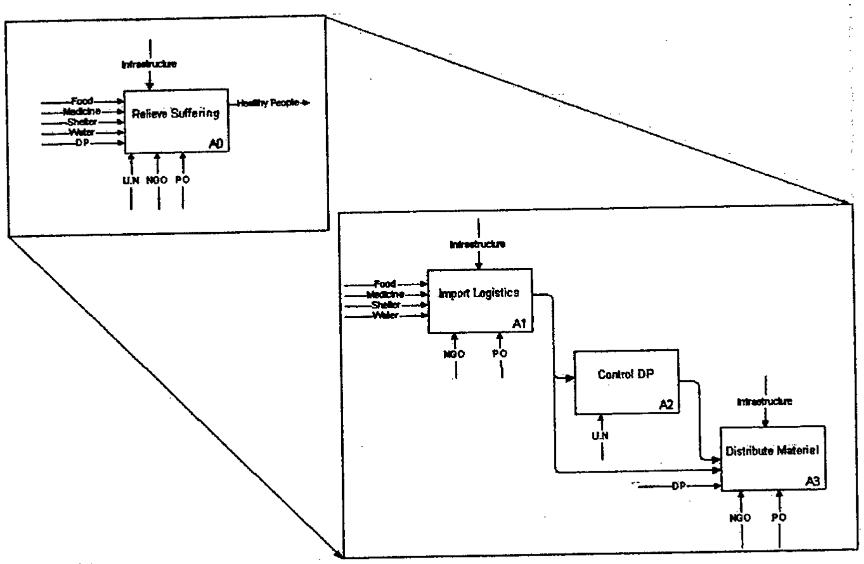

Figure 5: IDEF Function Decomposition

To this point in the analysis, the tasks identified are conducive to individual or limited concurrent work by members of the staff. Relating structure to process, the final step in defining systemic structure, though requires collective involvement of all staff members. There are three products that can result from the relationship of structure to process: definition of the existing systemic structure, identification of archetypes, and identification of center(s) of gravity.

Defining systemic structure involves determining how structure relates to process. For every given process identified there will be both human and natural systems performing and influencing the process. Likewise, the actions of every human system will produce feedback that will have effects on other systems and processes in the environment. Both assertions are basic to the laws of open systems. Systemic structure is the definition of those relationships. Defining the systemic structure is the act of analysis necessary to determine leverage points for the problem situation at hand. By relating processes to the human organizations performing and acted upon by processes, staffs build a composite model of process and structure that can indicate potential areas that can be acted upon to improve the situation. On the surface, examination and definition of the relationships in a complex problem appears intractable even on the relatively small scale of Operation Support Hope. However, use of identified processes as start and focal points offer insights to economies in analysis.

As a technique, relating process to structure begins with the selection of a process – usually one that intuitively has relevance to the problem situation. The process is displayed to the assembled staff and in a controlled rotation, each staff element in turn indicates any relationship that his personal work, be that identification of structure or other processes, may have on the process. A graphical technique at this point is construction of a simple influence diagram that indicates relationships among several entities (Figure 6).

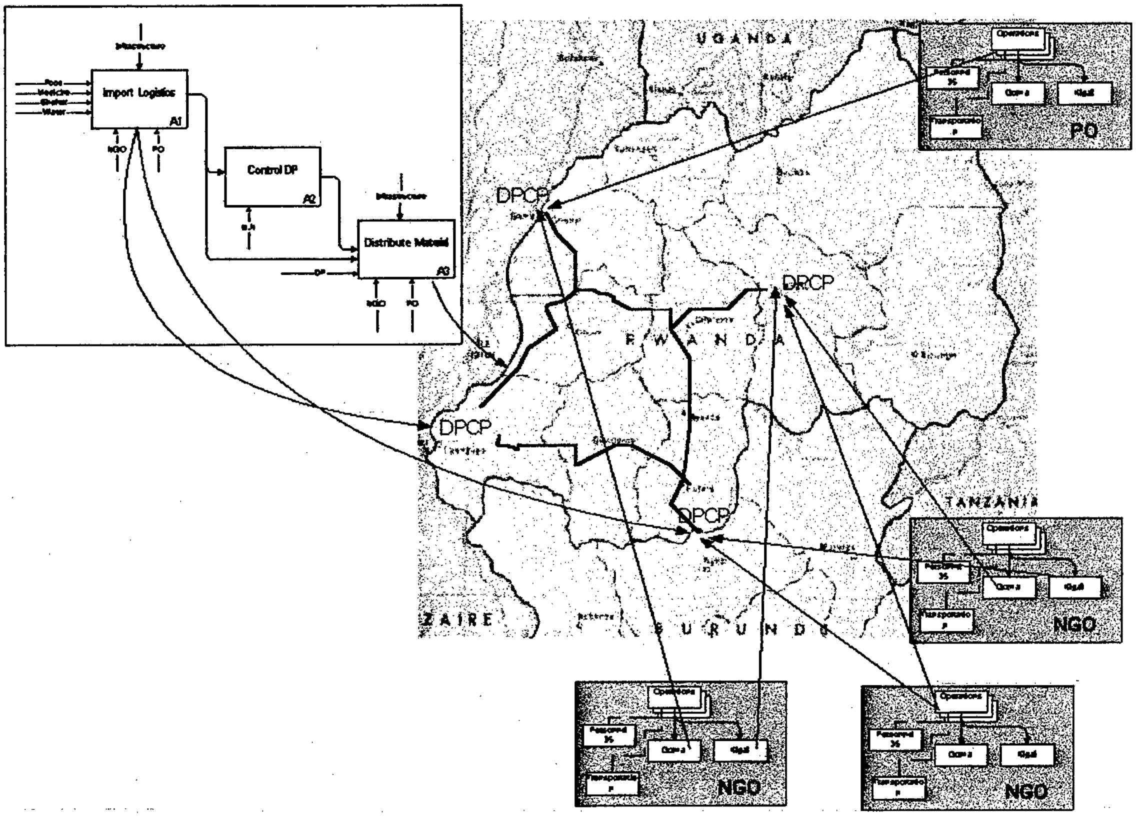

Figure 6: Influence Diagram

The method continues until all processes have been analyzed. Likely outputs from the step are additional requests for information, the identification of more processes that require definition, the identification of additional structure that requires definition, and early indications as to which parts of the systemic structure need further levels of detail to support latter phases of the decision making process. At completion of this step, the staff will likely have several models that collectively represent the existing systemic structure for the problem situation, at this point in the analysis the staff can begin to make inferences about cause and effect relationships.

The final and most important step in the Define Systemic Structure phase of systems mission analysis is defining cause and effect relationships. This is by far the most intangible of the systems techniques but potentially the most beneficial from the standpoint of payoff to visualization. The step involves inferring from work done to relate structure and process any patterns of causation for effects that are observed in the problem environment. The primary inputs for this step are the composite of models representing the existing systemic structure, information on current conditions and activities in the problem environment, and critical thinking from the collective staff. The output for this step is synthesis, and consists of both an estimate of the existing, relevant systemic structure and estimates of centers of gravity for the key organizations operating in the battlespace. The primary systems technique that applies is Senge's link and loop diagramming.

As both Senge and Checkland point out there is no rote procedure that guarantees identification and definition of the cause and effect relationships relevant to any given problem situation. Both systems thinkers recognize though that it is important to represent a variety of viewpoints, some of which may conflict, in order to start the visualization process and begin to structure the problem environment. As noted by Senge, for any goal-oriented behavior there are two basic feedback mechanisms, reinforcing and balancing. How those two forces act with respect to goals and objectives gives insight into where staffs can act to get the greatest benefit for the effort – leverage. Examination of all of the systems archetypes (Appendix C) shows that they are differing combinations of reinforcing and balancing forces acting with respect to goals and the environment. Each different feedback process has different leverage points. Senge's links and loops technique represents a simple tool that can be applied directly to the SS operational environment.

As the start point for cause-effect analysis, planners should identify the condition of most immediate concern – the condition could correspond to the purpose of the stability or support operation. The intent though is to focus on a perceived condition for which the staff will determine causation. An example is Operation Support Hope in Rwanda, 1994. There the event of most immediate concern to U.S. forces was *thousands of people dying daily*. Using the links and loops technique requires the transcription of the event to one or several graphical models (appendix C-2) that represent "classical stories of systems archetypes".[70] Early in the mission analysis process, planners may not have sufficient information to immediately identify correct or appropriate archetypes, which is not in and of itself a problem. The process of fitting systemic structure to different archetypes is itself part of the visualization process and helps to formulate common mental models. Continuing with the Operation Support Hope example, a possible application of the technique is fitting the problem to the balancing archetype (Figure 7).

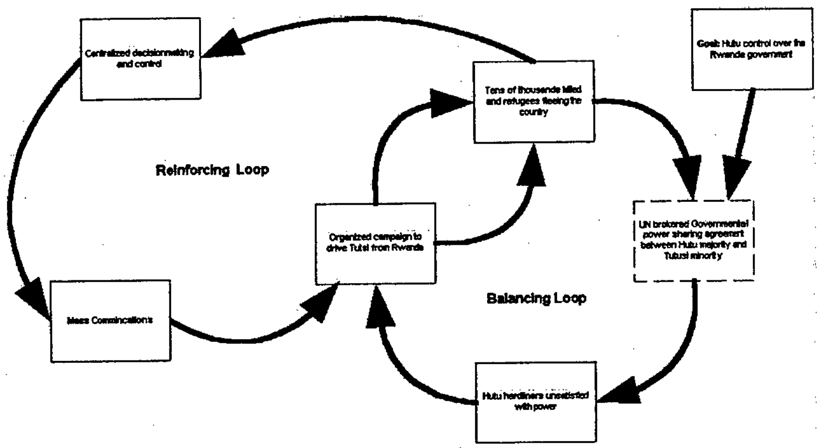

Figure 7: Balancing Archetype

Use of the system archetype template then serves several additional purposes. First, the required and optional elements of the archetype that should be filled-in serve to focus information collection and analysis and generate information requirements. Second, if planners develop the models as a team, or individually and discuss the models as a team, the models serve as tools to identify varying viewpoints on the same issues, e.g. the civil-military affairs planner may have a different perspective as to relevant patterns than the logistics planner (Figure 8). Finally, the system archetypes will generate ideas on other processes, structure or feedback loops that exist and have potential relevance to the problem.

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[70] Senge, Kleiner, Roberts, Ross, and Smith, *The Fifth Discipline Fieldbook,* 121

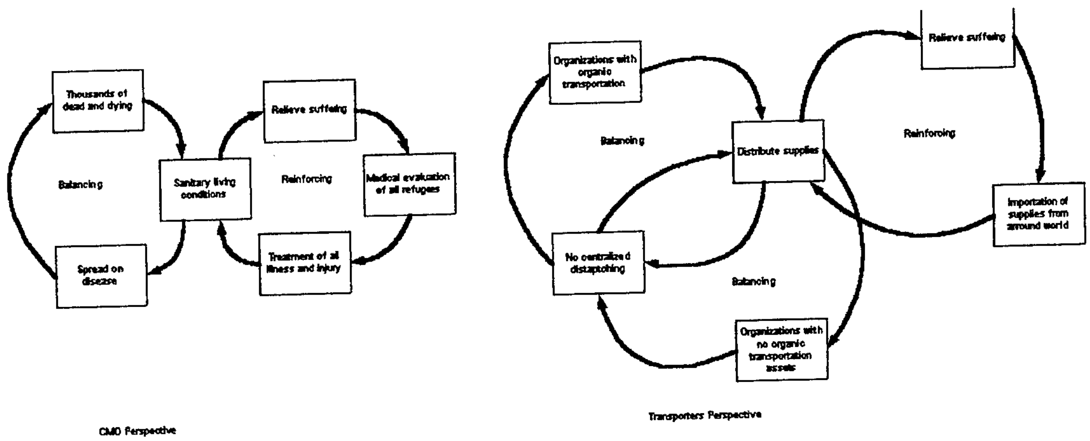

Figure 8: Different Process Perspectives

As with modeling done for organizational structure, there is the potential for the identification of a complicated mosaic of relevant feedback processes. For any given feedback process, there can be any number of elements that fully define the actions and reactions at work in the system archetype. Similar to the Organizational Influence Diagram there can be any number of archetypes in play and relevant to the problem at any given time. Using the same graphical tool used for the organizational influence diagram, staff members can relate or link loops to indicate influence among two or more archetypes all operating at the same or at different hierarchical levels. Attention is again required to fully define any identified relationship. Staffs should save all detailed information supporting archetype diagrams in system folders.

Once the staff defines archetypes, the process then involves determining how human and natural systems relate to the feedback process. In effect, determining for every element in a given archetype model what human and physical systems are involved, focusing again on the feedback forces working counter to the goal of the process under analysis. Relating structure to process in this way reveals both procedure and structure that can be acted upon to get desired changes in the system. It is important at this point in the analysis to remember that the staff is only conducting mission analysis, not course of action development. Given time constraints, the staff's focus is on defining the relationship of structure and process to feedback working counter to the goal because that is normally where leverage is found. In concept, the process is simple, given a reinforcing process; leverage is found in the identification and removal of all balancing forces acting on the process. Similarly, given a balancing process; leverage is found in the identification and removal of all reinforcing forces acting on the process. The resulting systemic structure is still only descriptive in that it defines for the commander the situation on which he may choose to act.

Another output and potential benefit of defining systemic structure is the identification of potential centers of gravity for the entities relevant to the problem. U.S. Army doctrine defines the center of gravity as the hub of all power and movement, on which everything depends. Similarly U.S. Joint doctrine defines the term as those characteristics, capabilities, or localities from which a military force derives its freedom of action, physical strength, or will to fight.[71] An abstract application of the term is the identification of a center of gravity with respect to a structure or process that influences several archetypes. In applying the center of gravity concept to a feedback process, one quickly identifies the similarity to Senge's definition of leverage. In both the terms is the recognition of some singularity upon which the entire system is dependent. By graphically representing the relationships among processes, structures and feedback loops, there is potential for patterns to emerge indicating the central involvement of an organization and/or process to the problem – in effect a leverage point or center of gravity.

Applied to Operation Support Hope, the feedback processes indicate several potential leverage points as well as the center of gravity for one of the human systems involved (figure 9). The model represents on one page the complex, balancing feedback process between organized ethnic massacres and the Hutu goal to retain control of the Rwandan government. The reinforcing loop indicates how the Rwandan military system and communications systems combine to provide the means (or reinforcing mechanism) for the organized massacre of the Tutsi minority. Similarly, the interrelationship of the Presidential Guard with several of the key

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[71] Headquarters, Department of the Army, *FM 101-5-1,* 1-24.

variables in both the reinforcing and balancing loops indicates the guard as a potential center of gravity for the cause and effect relationship.

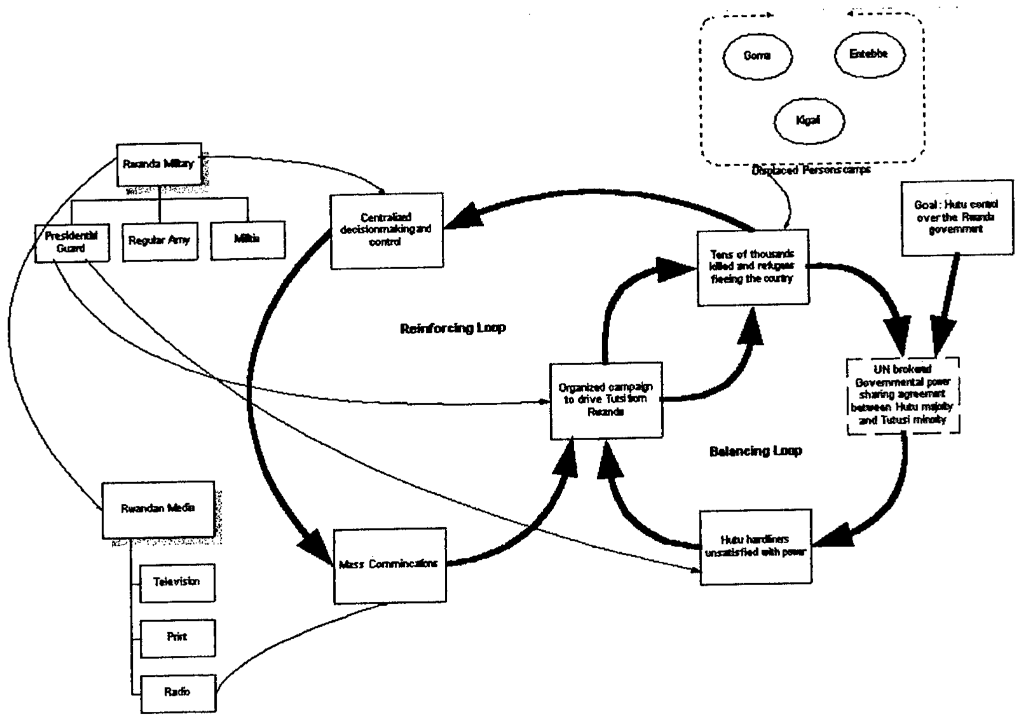


Figure 9: Rwanda Systemic Structure

Figure 9 represents only one of several models that would comprise the systemic structure of Rwanda prior to the start of Operation Support Hope. The figure is illustrative though of the power of the technique to simply represent complex causal relationships and therefore communicate common situational understanding.

Analyze Tasks

(Appendix F-3: MA3) The third step of Systems Mission Analysis is Analyze Tasks. Analyze Tasks is very much consistent with current U.S. Army doctrine for the step, focusing on the identification of specified, implied and essential tasks that the command must accomplish in the course of the current operation. The primary inputs for the Analyze Tasks function are the higher command's OPORD, the nesting diagram completed in the Analyze OPORD step of systems mission analysis, and the most current version of the existing systemic structure. Primary output for this step of systems mission analysis are specified, implied and essential tasks represented in a nested, critical path method (CPM) diagram. The phase consists of four subordinate steps, determine specified tasks, determine implied tasks, determine essential tasks, and create CPM diagram.

As noted, the determination of specified, implied and essential tasks are largely consistent with current U.S. doctrine as detailed in FM 101-5: *Staff Organization and Operations*, and as such will not be restated here. Of note though is the availability of the most current version of the existing systemic structure for the identification of potential implied tasks. Situational understanding gained through modeling the existing systemic structure provides the potential for the early identification of tasks necessary for mission accomplishment.

New to task analysis is the use of critical path method modeling techniques to represent the relationships among specified, implied and essential tasks both at the current level of command and nested with higher and adjacent units. Though not addressed in previous chapters as a product of any of the major subdivisions of systems theory, the technique is common to the engineering management sciences and systems schools. Similar in execution to the nesting diagram in step one of systems mission analysis, CPM is a modeling tool for the graphical representation of task relationships with the added component of time. CPM modeling uses the terms activities, defined as actions that require the expenditure of resources, and events, defined as points in time that do not require expenditure of resources, as tools to represent the relationship of tasks with respect to time. Graphically, arrows represent activities and circles represent events. As a rule, events will always occur at the start or end of an activity (Figure 10).

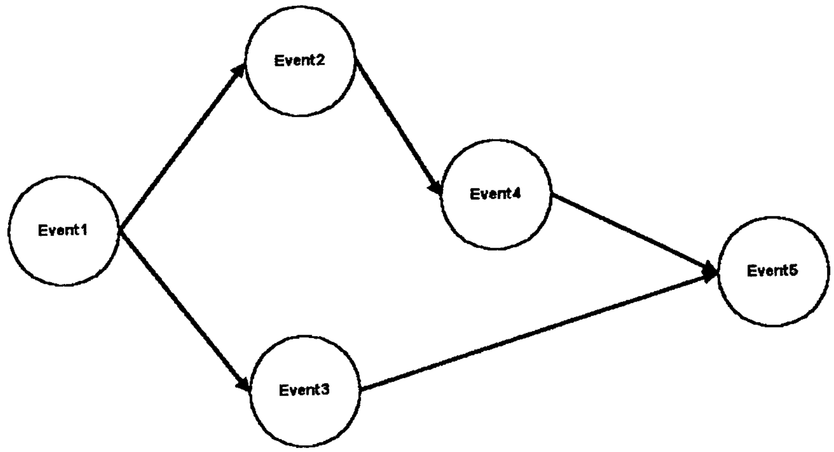


Figure 10: CPM Network Model Example

For purposes of task analysis, specified, implied and essential tasks will all equate to activities while key points in time such as executing the line of departure, decisions, or the achievement of an objective will equate to events. The result of matching activities with events through CPM diagramming is the framework for logical lines of operations as described in FM 3-0.[72] The product is only a framework for logical lines of operation because the staff is conducting mission analysis, not course of action development. In later stages of the decision making process, the CPM diagram could be further developed to accurately represent the decided upon course of action to exacting detail.

The final significant attribute of CPM modeling is the introduction of time to task analysis. For every activity, staff planners will make estimates as to the amount of time the tasks will require. The benefit for both the staff and the commander is the inclusion and consideration of the effects of time on the operation early in the planning process. Time is recorded in the model as a range of estimates: earliest completion time, anticipated completion time, and latest completion time (Figure 11).

[72] Headquarters, Department of the Army, *FM 3-0,* 5-9.

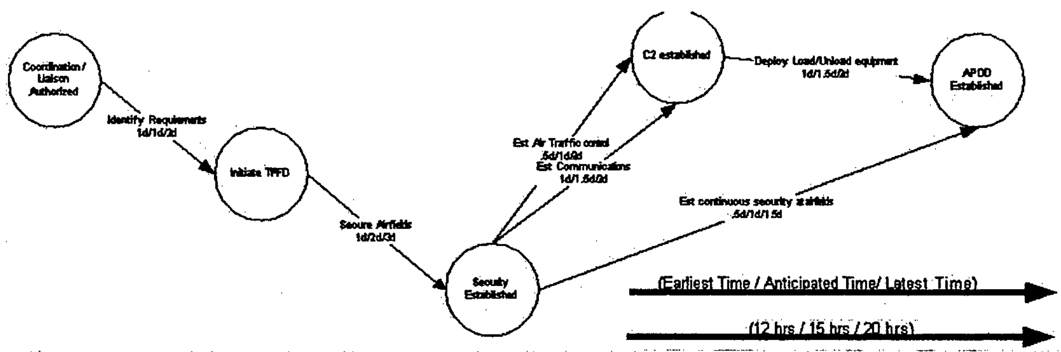


Figure 11: CPM Activity Labeling

For commanders the combination of time estimates and the relationship of tasks can provide insights into feasibility, resource allocation, the determination of main and supporting efforts at different points in the mission, as well as early indication of potential Friendly Forces Information Requirements (FFIR).

Determine Problem Bounds

(Appendix F-4: MA4) The fourth step in systems mission analysis is the determination of problem bounds. The purpose of this phase is consistent with current U.S. Army mission analysis in that the phase defines for the staff and commander the solution space for feasible, acceptable and suitable courses of action. The primary inputs for this phase are the higher operations order, results from requests for information, the mission timeline, and the battlespace components. The primary outputs for the phase are requests for information, known constraints, planning assumptions, estimates of acceptable risk, and determination of available assets. There are four subordinate steps to the phase: review available assets, determine constraints, determine assumptions, and determine risk.

Reviewing available assets involves two functions: review organic assets and review assets of the higher command that may be leveraged. Review of organic assets is a cross-battlefield operating systems function that provides for the commander and staff situational understanding of the condition, readiness, and capabilities of the materiel and personnel assigned to the command. Condition speaks directly to the physical state of the materiel and personnel; information requirements include units' strengths and maintenance status. Readiness addresses the potential for the unit to execute operations. For instance, a unit may be ninety percent on equipment and personnel only as the result of recent reorganization, leaving the unit less ready from a command and training perspective than a unit operating at eighty percent on materiel but with cohort personnel. Capabilities address what a given unit can do in time space. Unit experience and training directly relate to the ability of the unit to perform certain missions and tasks. Staffs must have an understanding of unit capabilities in order to make estimates of how units can be expected to perform assigned tasks with respect to time. A well-trained and experienced unit can be expected to perform certain tasks in less time than an inexperienced unit does. Such information may have bearing on the assignment of tasks to units during later stages of the decision making process. As a technique, the staff can assess unit capabilities against the range of tasks identified during the development of the nested CPM diagram.

Determination of constraints is done across all battlefield operating systems. The purpose is to identify conditions that may restrict the unit's freedom of action. Constraints can be both positive or negative in the sense that they can be requirements to do something, prohibitions from doing something or hard limits in the availability of resources that preclude doing something. As a technique, constraints must meet a "so-what" criteria before being listed. Influence diagramming as done in steps one and two of systems mission analysis is a tool to visualize the potential impact of identified constraints. By graphically relating constraints to the existing systemic structure and the nested CPM diagram, staffs and commanders can visualize potential ordered effects of a given constraint. As a rule, if relationships between systemic structure and the constraint cannot be determined, then the constraint is in all probability not relevant to the situation.

Determination of assumptions is done across all battlefield operating systems. The purpose of making assumptions is to complete the set of information required to conduct further planning. Assumptions are a critical, if not often overlooked component of problem solving and complexity. As with the other components of defining the problem bounds, assumptions to be recorded must have significance to the problem. Significance is again defined by having influence on one or more aspects of the problem structure. Influence diagramming is again a useful tool to graphical depict the potential influence that particular assumptions have to planning as the result of the assumption's demonstrated relationship to systemic structure.

The final step of the define problem bounds phase of systems mission analysis is determination of risk. Risk assessment is consistent with current U.S. Army doctrine and involves the determination of both hazards to friendly forces and estimates of where tactical risk may be acceptable.

Develop Conceptual Model

(Appendix F-5: MA5) Development of the conceptual model for the problem situation is the decisive step of systems mission analysis. The first four steps of the systems mission analysis can in large part be done concurrently, but all four steps must be complete in order to provide the input necessary to develop a conceptual model. The purpose of developing a conceptual model is to define the common situational understanding from which the staff and commander will develop courses of action. Inputs for this phase of the analysis are all of the major outputs from the previous four phases. The Primary outputs for the phase are the estimate of the systemic structure of the problem, a conceptual model of the relevant systems to act on, and estimates of potential decisive points for use in course of action development. The phase consists of four subordinate steps: Define U.S. Systemic Structure, Integrate Systemic Structures, Determine Relevant Systems, and Determine Decisive Points.

Defining the U.S. systemic structure is different procedurally to that done to determine the existing systemic structure in step two of the systems mission analysis process. The purpose is to relate the tasks, purposes and objectives mapped during Task Analysis with the set of bounds identified in the Determine Problem Bounds phase of the analysis. The systems techniques are identical to those used in phase two, with emphasis placed on U.S. and multinational forces for which there is command and/or supporting relationships either identified or already established. In concept, defining the U.S. Systemic structure involves the conversion of traditional task and purpose statements into link and loop, archetype templates. For every archetype or suspected archetype identified, problem bounds are then mapped to each event in the model consistent with the existing systemic models developed in phase two of the mission analysis. It is very likely that at this phase of the analysis there will be multiple archetype templates that are considered appropriate to the problem. This is completely acceptable during mission analysis. For example the mission statement for Operations Support Hope "to provide assistance to humanitarian agencies and third nation forces conducting relief operations in theater to alleviate the immediate suffering of Rwandan refugees" could be interpreted as either a reinforcing loop or limits to growth loop which recognizes limits to the ability of the operation to relieve refugee suffering (figure 12).[73]

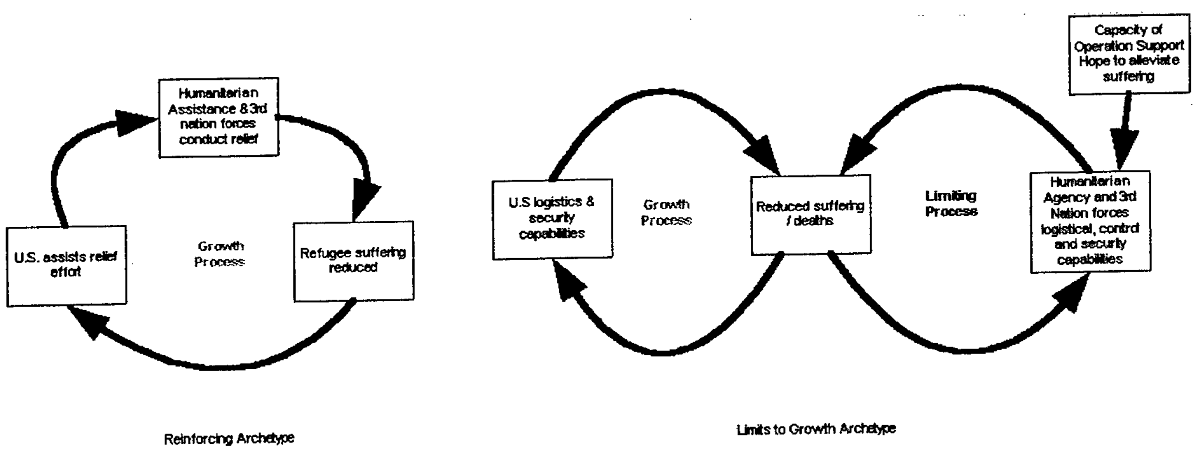


Figure 12: Support Hope Mission Statement

As with step two of systems mission analysis, multiple perspectives are important to building as rich an understanding of the problem situation as possible. An immediate effect of multiple perspectives is to increase the likelihood of identification during mission analysis of potential

[73] Seiple, *The U.S. Military/NGO relationship in Humanitarian Interventions,* 145.

second and third order effects. Links and loops are a tool to visualize cause and affect relationships. Multiple perspectives of the same problem therefore represent conceptualization of different ways that U.S. actions can influence the existing systemic structure.

The second subtask of Develop the Conceptual Model is the integration of the existing systemic structure with the U.S. systemic structure. The outcome of this step will be the staff's estimate of how U.S. aim, force structure and processes will relate to the other organization's aims, structure and processes within the problem space. The process for integrating systemic structures is an exercise in critical thinking, relying on full staff participation and access to all of the information collected and modeled to that point in the analysis.

Similar in method to integrating process and structure in the define systemic structure phase of mission analysis, the staff begins by displaying one of the archetypes for U.S. operations. For that specific archetype, the staff then posts the nested CPM diagram indicating all of the identified tasks that relate to the archetype. With the U.S. systemic structure as the background, the staff then collectively identifies where and potentially when U.S. activities will interact with elements of the existing systemic structure. Graphically the staff can concurrently display models of both the U.S. and existing systemic structures and use arrows to indicate influence or interaction.

The ultimate goal of this step of mission analysis is to provide the commander with visualization of potential cause and effect relationships associated with the interaction of the U.S. system and other systems operating in the environment. As indicated previously this is not course of action development, but rather a method to provide the commander with visualization of a complex environment to a degree of resolution that will permit the determination of feasible courses of action with some probabilistic knowledge of second and third order effects. Continuing with the Operation Support Hope example, figure 13 depicts the integration of several of the products used as examples to this point.

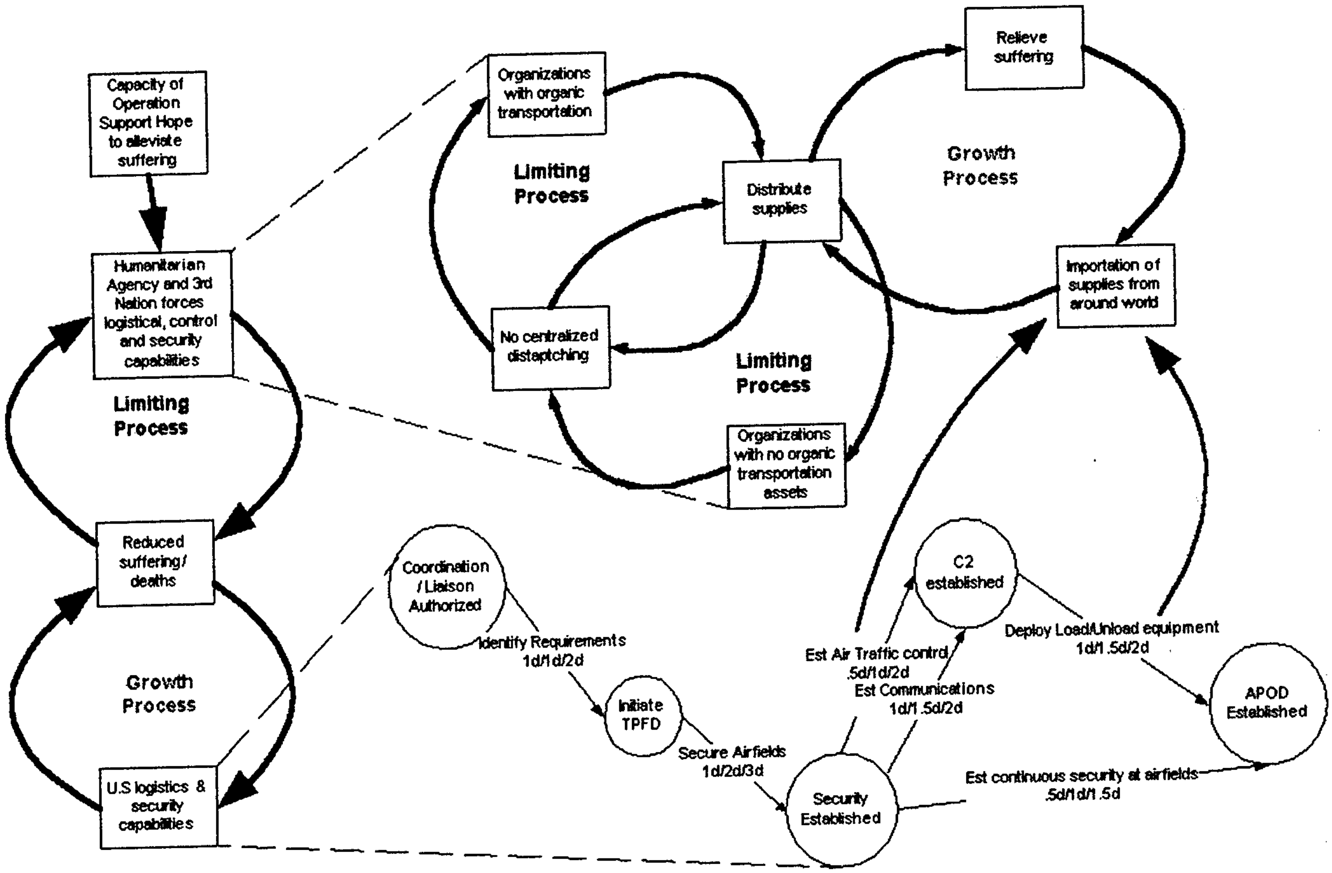


Figure 13: Conceptual Model

The example indicates that although specified U.S. tasks address a component of the distribution process affecting the operation's ability to relieve suffering of displaced personnel, the specified tasks fail to address balancing forces that negatively influence the system's ability to distribute supplies once in theater. Graphically, the conceptual model indicates the failure of the current plan to address potential leverage points. The conceptual model also presents to the commander and staff the potential for decisive points for consideration in course of action development. The power behind the use of archetypes is that they provide immediate insight into where action can be taken to most effectively address the problem situation modeled. As with previous systems mission analysis products, figure 13 represents only one example of what more likely would be several conceptual models, representing relevant systems that U.S. forces can and will influence.

Develop Guidance

(Appendix F-1: MA0) Developing guidance involves those tasks necessary to focus the staff for the remainder of the decision making process. The prerequisite for this phase of systems mission analysis is the completion of steps one through five of systems mission analysis. Inputs for this phase are conceptual models, estimated center(s) of gravity, and estimated decisive points. Outputs for this phase are the restated mission, initial commander's intent, and the commander's guidance. The phase is divided into three sub-tasks that correspond to the develop guidance phase's outputs. The subtasks largely concur with current U.S. doctrine for mission analysis with the exception of the introduction of references to systemic structure and conceptual models. Restating the mission and developing initial commander's intent must be completed prior to the development of commander's guidance for planning.

Restating the mission involves synthesis of the mission analysis and the conversion of that synthesis to a concise statement that contains the elements: who, what, when, where, how and why.[74] Also included in the mission statement are all on-order missions. Determining the mission is a commander's function, enabled by the conceptual model of the situation. The conceptual model will reveal the essential tasks, their purpose, and the timing that will achieve the commander's desired end state for the operation.

Developing initial commander's intent requires that the commander design a clear and concise statement of what the force must do to succeed with respect to the concept models and the desired end state. The format is consistent with current doctrine in that it requires the commander to identify what he considers decisive to the operation, the key tasks that must be accomplished, and the his vision of end state with respect to friendly forces, other systems operating in the battlespace, and space. One difference with current doctrine is that key tasks may also reference systemic structure and conceptual models as opposed to pure reference to problem

[74] Headquarters, Department of the Army, *FM 101-5,* 5-8

structure. For example, the commander might organize the problem space by allocating forces to minimize all of the identified balancing forces affecting the food distribution process as a shaping operation. Cause based tasks are consistent with providing subordinate commanders the basis for exercising initiative. Similar to mission type orders, cause based tasks target a cause and effect relationship identified through conceptual modeling and permit the subordinate unit to determine the specific ways of achieving the desired effect.

Developing the commander's guidance is the final sub-task of the develop guidance phase of systems mission analysis. Consistent with current doctrine the purpose of the guidance is to provide the staff with focus for the remainder of the decision making and planning process. The key element of the guidance is the selection of the relevant conceptual models that the staff and subordinate units will use as the basis for the rest of the planning process. As noted herein, there will likely be multiple conceptual models developed by the commander and staff, some of which may represent conflicting or divergent estimates of cause and effect relationships active in the situation. The commander has the discretion to direct course of action development and detailed planning on any combination of conceptual models. For example, the commander could direct the development of several courses of action specific to a single conceptual model, or the development of one course of action for each of two, divergent conceptual models. Whatever the commander's decision, the conceptual model(s) selected become the common point of reference for the command.

Determine Measures of Effectiveness

(Appendix F-7: MA7) The final step in systems mission analysis is the determination of measures of effectiveness. The purpose of determining measures of effectiveness is to identify the conditions and or effects that will indicate the status of the unit's efforts to meet the commander's objectives and vision for end state. The primary inputs for this phase of mission analysis are the restated mission, initial commander's guidance, relevant conceptual models, and acceptable risk. Outputs for this phase are the initial Commander's Critical Information Requirements (CCIR) and requirements for redefinition of tasks and objectives. The systems theory tools applicable to this phase are the cybernetic theory of decision and the A-B-C-D systems model. There are three sub-tasks associated with determination of measures of effectiveness: enumeration of objectives, identification of feedback mechanisms, and determination of CCIR.

Measures of effectiveness constitute one of the fundamental elements of problem solving. In complex environments in which there is not a definitive blueprint for reality, measures of effectiveness serve as indicators for whether or not actions taken are changing the situation in the direction of the objective. The start point for the identification of measures of effectiveness is the enumeration of objectives and purpose. Because purposes and objectives are the primary input to the determination of measures of effectiveness, measures can largely be developed concurrent with the development of the conceptual model. Given that there will be multiple objectives that the unit must balance, hierarchically arrange and relate the objectives in order of priority to the commander.

Once the staff has arrayed the objectives, the next step in the process is to determine what feedback will indicate when the unit has achieved each of the desired outcomes. Although the commander identifies in his guidance the conditions that define end state, those conditions do not represent feedback – they more closely represent a goal than a measure. As the result of development of conceptual models, the staff has already completed much of the work in determining sources for relevant feedback as the measures lie in cause and effect. The staff must translate identified cause and effect relationships into measurable feedback. Actual feedback will be as varied as are cause and effect relationships. A common characteristic among useful feedback mechanisms though is measures of change over time. Change with respect to both the objective and time provides the commander and staff with indications of whether or not actions taken are having the intended effects. Determination made on whether trends are positive or counter to the objective then provide macro level indications of the need for changes to operations.

An important aspect of measures that the commander and staff must understand is delay in effect. All feedback mechanisms must take into account the delay between when action is taken and when there should be a measurable effect. Failure to recognize that it takes time for actions to have effect throughout a system can cause premature, unnecessary or even critically wrong decision-making. Similarly, too large a delay between when action is taken and efforts to measure feedback creates conditions for missing potentially significant indicators of the need for a decision. The obvious implication is that critical thought must be given to where and when to measure for effectiveness.

As a technique, the conceptual models should serve as the primary tool for determination of what and when to measure. Because the conceptual models represent the integration of cause, effect and systemic structure, they should provide the commander and staff with ideas of both structure and process that they can leverage for feedback on performance. The staff should include with all identified feedback mechanisms an estimate for when the to-be-determined collection source should measure the feedback mechanism. Conceptually, individual feedback mechanisms are sampled at specified points in time and the information collected then serves as discrete measures of performance that can be compared over time to determine trends. The staff and commander can then use trends, or behavior over time, to evaluate the effectiveness of actions taken with respect to objectives and purpose.

The final step in determining measures of effectiveness is the determination of Commander's Critical Information Requirements. Not all measures of effectiveness rise to the level of significance that requires a decision or action by the commander. Though valuable information, measures not requiring a commander's decision are matters for the staff and are by necessity lower in priority for resources than information that directly relates to decisions the commander will need to make. Those measures of effectiveness that are identified as relating to decisions that the commander will need to make in the course of the operation should be designated as CCIR. Consistent with current U.S. Army doctrine on critical information, CCIR represent that subset of information that the commander must have, and therefore represent a priority for collection and analysis. Unlike the current U.S. Army definition for CCIR, the information required by the commander in SS operations does not necessarily conform to Priority Intelligence Requirements (PIR) relating to enemy forces not to Friendly Forces Information Requirements (FFIR) relating to U.S. and joint/coalition forces. The definition of CCIR for purposes of systems mission analysis is modified to be any information relating to the need for a decision by the commander.

Remaining with the Operations Support Hope example, relevant measures of effectives could be rates determined for numbers of displaced persons, shelter less persons, and deaths. The staff would necessarily calculate rates from point measurements taken over time. Given that all of the measures are subsequent to the completion of specified tasks such as establishing air points of debarkation, and implied tasks such as establish the civil-military operations center, the staff can use the CPM diagram to reasonably estimate that there will be a delay of at least one and possibly two weeks before any effect will be measurable. It is important though to get baseline measurements early, so that as supplies begin to reach those in need, any effects the supplies have can be measured. Given that stopping the dying was a stated purpose for the operation, death rates for displaced persons fits the modified criteria for a Commander's Critical Information Requirement.

CONCLUSION

Review of Research Questions

This monograph demonstrates that systems theory can form the basis for useful, standardized techniques and procedures for conducting mission analysis in stability and support operations. The ultimate goal of the research was to discover, develop and apply actual techniques and procedures thus demonstrating the feasibility and suitability of systems theory to helping military planners better visualize and understand complex problems. The culmination of the research is the notional model for systems mission analysis presented in Appendix F and applied to the humanitarian emergency in Rwanda in 1994.

Fundamental to the suitability and acceptability of systems theory to mission analysis is the recognition that U.S. doctrine for mission analysis is inadequate to the requirements of the stability and support operational environment. The inadequacy of current doctrine to the stability and support operational environment results from the nature of the complexity involved, the influence of problem aim on the perception of complexity, and the influence of experience on problem solving. Collectively the factors combine to define the stability and support problem environment as a problem type that is distinct and different from the offensive and defensive operations problem environment.

Though comparable in terms of structural complexity and the fact that both problem types exhibit dynamic complexity, there is a difference in the perceived complexity of Stability and Support operations vis-à-vis Offensive and Defensive operations. The difference in the perceived complexity results from the interaction of problem aim and problem solving experience with problem structure. The relative clarity in aim and purpose characteristic of offensive and defensive operations coupled with the U.S. military's experience with offensive and defensive operations shapes the problem environment to where uncertainties in cause and effect are reduced to the point that analysis is largely detailed and systematic. This contrasts with stability and support operations where often ambiguous aim and purpose coupled with relative inexperience combine to create a problem environment where dynamic complexity dominates analysis, and ultimately mission accomplishment. The dominance of dynamic complexity effectively creates a different problem type from that of conventional offensive and defensive operations.

Current U.S. mission analysis doctrine is largely appropriate to any military operation, but there are steps and products that are highly tailored to the offensive and defensive operational problem. The tailoring represents a purposeful departure from generic problem solving to more specialized problem solving appropriate to the offensive and defensive operational problem type. Such tailoring, though optimal for offensive and defensive mission analysis, is sub-optimal for stability and support operations. Given the dominance of dynamic complexity in stability and support operations, the guidance in current doctrine to collect more detailed information without specific reference as to how that information can be used to define dynamic complexity fails to address the fundamental characteristic that sets stability and support operations apart from offensive and defensive operations. In so doing, current U.S. Army mission analysis doctrine fails to provide planners with adequate tools to support both planning and decision making.

Complex planning and decision environments such as that experienced by the U.S. Army in stability and support operations are not unique to the military. The research presented in this monograph demonstrates that practitioners in several disciplines have developed problem solving methodologies designed to deal with complexity as observed in the stability and support operational environment. Of particular value is the work that has been done in the field of systems theory. Academicians and private contractors in several systems theory sub-disciplines have produced detailed methodologies, techniques and procedures that have been successfully applied to real-world problem solving in business and government. Many of the systems tools currently in use offer the potential for direct application to military problem solving. Of particular potential is work done by Stephan Haines, Peter Senge, and Peter Checkland.

Stephan Haines developed numerous tools based upon his study and work in the field of general systems theory. At the heart of Haines' work is the identification of four concepts based on natural laws of open systems. Haines used his concepts of natural laws of systems to develop sixty-four tools to apply to complex organizational problems in business. Several of the concepts and tools Haines developed map directly to activities that occur in mission analysis, namely determination of current conditions, desired end state and feedback mechanism.

Peter Senge's work is based upon understanding how complex feedback processes influence behavior within organizations. Senge stresses shifting from the more conventional approach to problem solving of seeing parts to seeing wholes. Key to seeing and understanding wholes is an understanding of factors beyond hierarchical structure that are established either consciously or unconsciously by the choices people and organizations make over time. One tool that Senge developed is link and loop diagramming. Links and loops are a graphical tool for representing cause and effect relationships. Senge further developed the link and loop concept and through application identified thirteen archetypes that represent recurring systemic problems in complex human systems.

Peter Checkland developed, relative to the other systems techniques examined, the most substantive departure from conventional problem solving methodologies. The soft system methodology developed by Checkland recognizes that often in reality organizations are confronted by problems where the aim and goal is either undefined or at best vaguely formed. The soft systems approach is an alternate problem solving methodology designed to explore and define what is perceived to be complex and even chaotic behavior in real-world human systems. Although much of what Checkland developed goes beyond the activities associated with mission analysis, parts of his methodology directly map to visualizing and describing the problem situation and the identification of possible objectives.

Collectively the techniques and methodologies presented herein enabled the development of the systems mission analysis model defined in the third section of this monograph. The systems mission analysis model is the direct application or modification of existing, proven systems techniques to the problem of mission analysis in the stability and support operational environment. The model addresses the identified shortfalls in current mission analysis doctrine specific to stability and support operations and provides an alternative method for visualizing complex problem situations and representing analysis in a manner for decision makers to make judgments as to feasible courses of action.

Although the notional systems mission analysis model is presented as a stand-alone model for conducting mission analysis, there is nothing to preclude integrating individual steps or techniques with current doctrinal procedures for mission analysis. Given the concept for full spectrum operations, commanders may have to combine different types of operations to accomplish the assigned mission.[75] Just as current doctrine is sub-optimal for analyzing the dynamic complexity dominant in the stability and support problem type, systems mission analysis offers no obvious advantage in analyzing the offensive and defensive operation problem type. In such a planning environment the staff might very well choose to integrate functions from systems mission analysis with current doctrinal procedures to address the stability and support elements of the operational problem. The integration of mission analysis techniques therefore represents an optimization of problem solving methodologies.

Recommendations

To the extent of the author's research, this monograph represents the first attempt at both the integration of several successful systems theory sub-disciplines and their application to the military problem-solving environment. As such, the notional model presented herein requires further consideration and refinement before consideration for incorporation into doctrine. Towards that end, the author recommends the following actions:

- Apply systems mission analysis in a School for Advanced Military Studies' stability and support exercise. Direct half of the participating seminars to use systems mission analysis and serve as an experimental group with the remaining seminars acting as the control group executing current doctrine. Document all

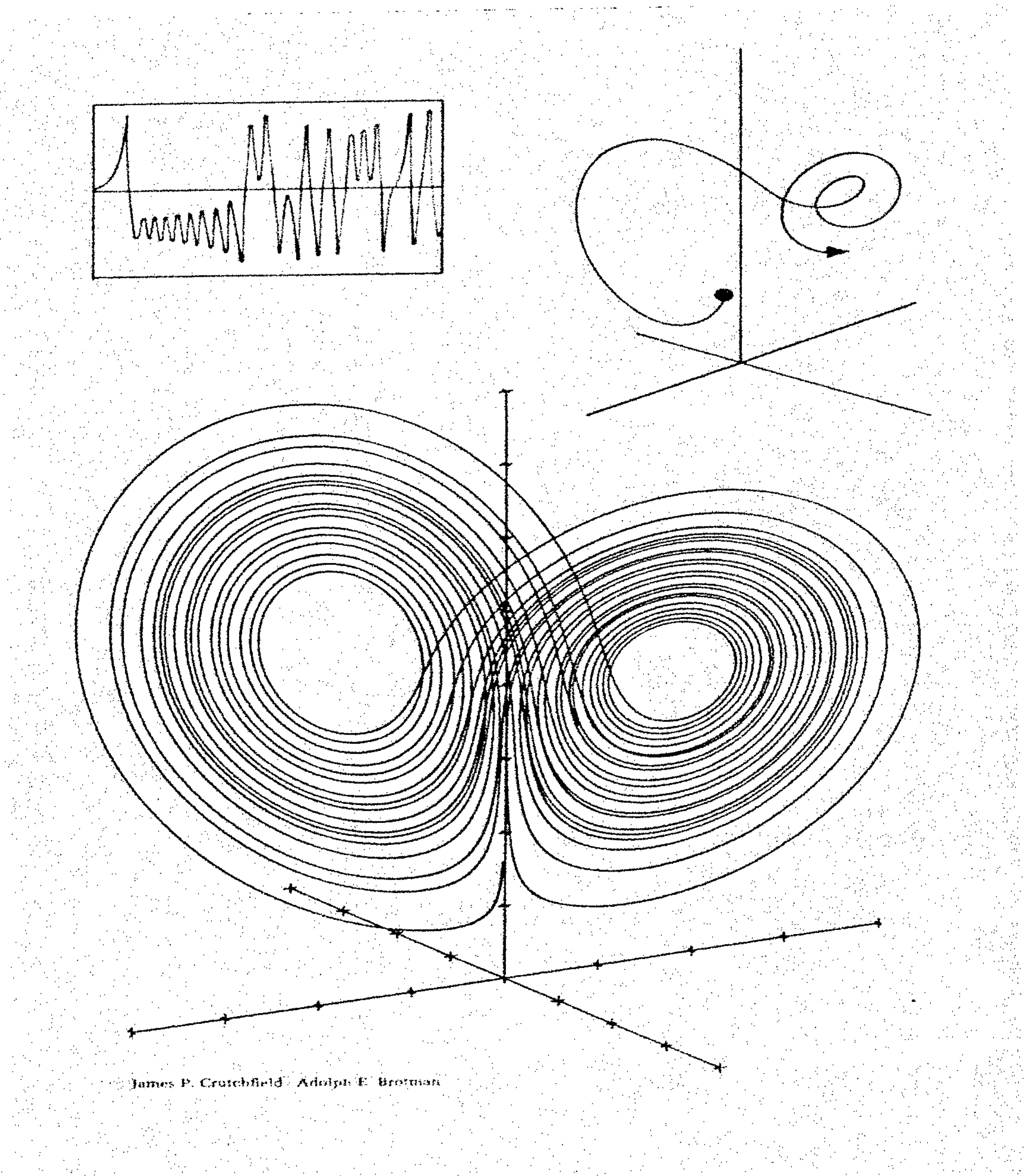
[75] Headquarters, Department of the Army, *FM 3-0,* 1-14.

lessons learned and recommendations and make necessary changes to the notional systems mission analysis model.

- Submit notional systems mission analysis model and TTP to Peter Senge, Peter Checkland, and Stephan Haines for evaluation, comment and suggestions.
- Submit notional systems mission analysis model and all feedback to Headquarters TRADOC for evaluation and consideration for incorporation into FM 101-5.
- Submit notional systems mission analysis model and all feedback to Commander, US Army Intelligence Center and Fort Huachuca for evaluation and consideration for incorporation into FM 34-130.

As with current mission analysis doctrine, systems mission analysis does not guarantee correct interpretation of a complex problem. Systems mission analysis doctrine does though guide the staff and commander to the identification and communication of cause and effect relationships within the problem environment. Unlike conventional linear problem solving that tends to focus on structure and ways to affect structure to achieve desired ends, the systems approach focuses on the relationships among structures and processes and from that systemic structure identifies cause and effect relationships that can be influenced to achieve desired ends. The technique offers the potential for the early identification of second and third order effects from action taken as well as creates potential for the identification of indirect means to achieve objectives. The systems mission analysis approach to analyzing a problem situation is different from currently prescribed methods and facilitates the realization and representation of complex causal relationships – a characteristic that alone is a potentially significant improvement to current doctrine for mission analysis.

APPENDIX A: Lorenz Output



Appendix 1: Lorenz Equations Output[76]

[76] Gleick, *Chaos: Making a New Science,* 28.

APPENDIX B: General Systems Theory Techniques

APPENDIX B-1: Seven Levels of Lining Systems

CONCEPT #1: Seven Levels of Living (Open) Systems

Hierarchy

1. Cell
2. Organ
3. Organism/Individual
4. Group/Team
5. Organization
6. Society/Community
7. Supranational System/Earth

Organizational Focus

Levels of Thinking

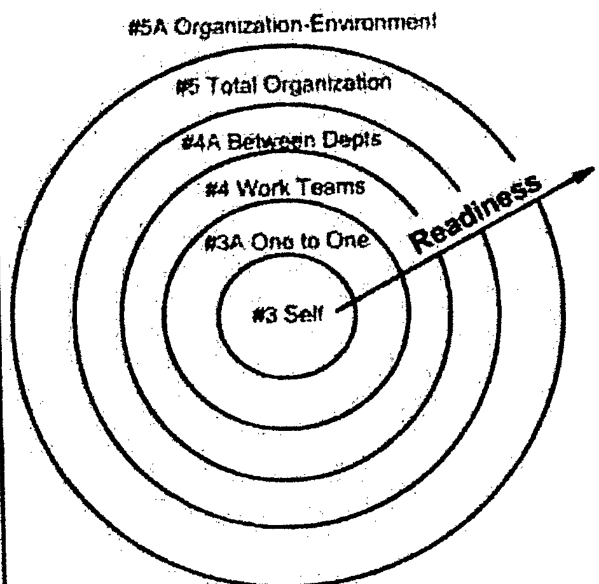
Problems that are created by our current level of thinking can't be solved by that same level of thinking.

—Albert Einstein

So . . . if we generally use analytical thinking, we now need real "Systems Thinking" to resolve our issues.

—Stephen G. Haines

Six Rings of Focus and Readiness



Increased:

- Complexity/chaos
- Readiness/willingness
- Skills growth

Note: Rings 3-4-5 are 3 of the "Seven Levels of Living Systems"

Rings 3A-4A-5A are "Collisions of Systems" with other systems

Adapted from General Systems Theory and Haines Associates, 1978.
Based on 1984 and 1995 literature searches and subsequent client feedback ever since.
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APPENDIX B-2: Standard Systems Dynamics

CONCEPT #2: Laws of Natural Systems
(Standard Systems Dynamics)

Natural Laws/Desired State vs. Experienced Dynamics

Natural Laws/Desired State

1. Holism—Overall Purpose Focused Synergy/Transformational
2. Open Systems—Open to Environment
3. Boundaries—Integrated/ Collaborative
4. Input/Output—How Natural Systems Operate
5. Feedback—on Effectiveness/Root Causes
6. Multiple Outcomes—Goals
7. Equifinality—Flexibility and Agility
8. Entropy—Follow-up/Inputs of Energy/Renewal
9. Hierarchy—Flatter Organization/Self-Organizing
10. Interrelated Parts—Relationships/Involvement and Participation
11. Dynamic Equilibrium—Stability and Balance/ Culture
12. Internal Elaboration—Details and Sophistication

12. A. Cycles of Change—Chaos and then Elegant Simplicity

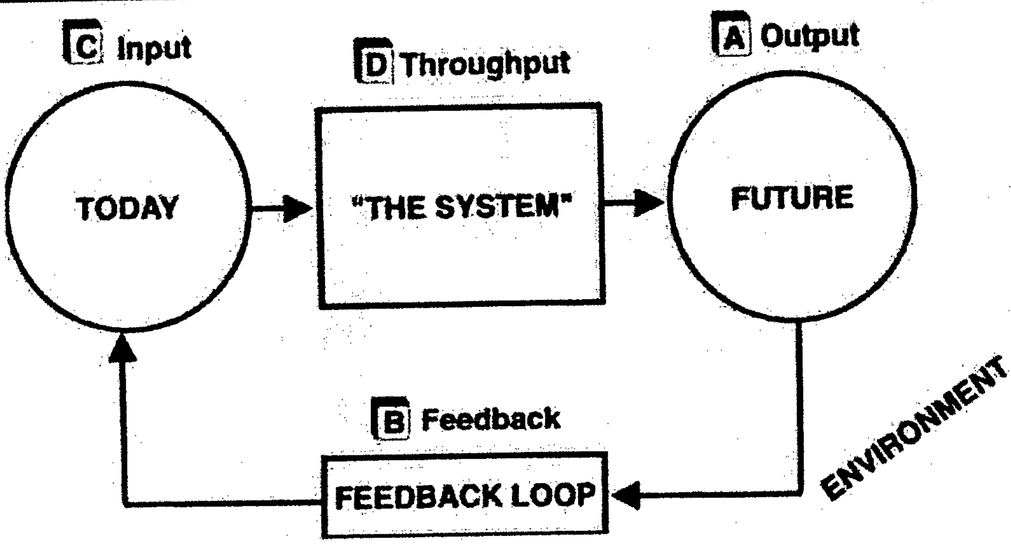
Experienced Dynamics

1. Parts/Activity Focused/ Suboptimal Results
2. Closed Systems/Low Environmental Scan
3. Fragmented/Turf Battles/ Separate/Parochial
4. Piecemeal/Analytic/ Sequential and Narrow View
5. Low Feedback/Financial Only
6. Artificial Either/Or Thinking
7. Direct Cause-Effect/ One Best Way
8. Decline/Rigidity/ Obsolescence/Death
9. Hierarchy/Bureaucracy/ Command and Control
10. Separate Parts/Components/Entities/Solos
11. Short-Term Myopic View/Ruts/ Resistance to Change
12. Complexity and Confusion

12. A. Individual/Sequential Change/New Problems Created

APPENDIX B-3: A-B-C-D Model for Systems

CONCEPT #3: A-B-C-D Systems Model



Four Questions in Sequence

A. Where do we want to be? (i.e., our ends, outcomes, purposes, goals, holistic vision)

B. How will we know when we get there? (i.e., the customer's needs connected into a quantifiable feedback system)

C. Where are we now? (i.e., today's issues and problems)

D. How do we get there? (i.e., close the gap from C ➔ A in a complete and holistic way)

Why Thinking Matters

The way you think creates the results you get.

The most powerful way to impact the quality of your results

is to improve the ways you think.

"How you think ... is how you act ... is how you are."

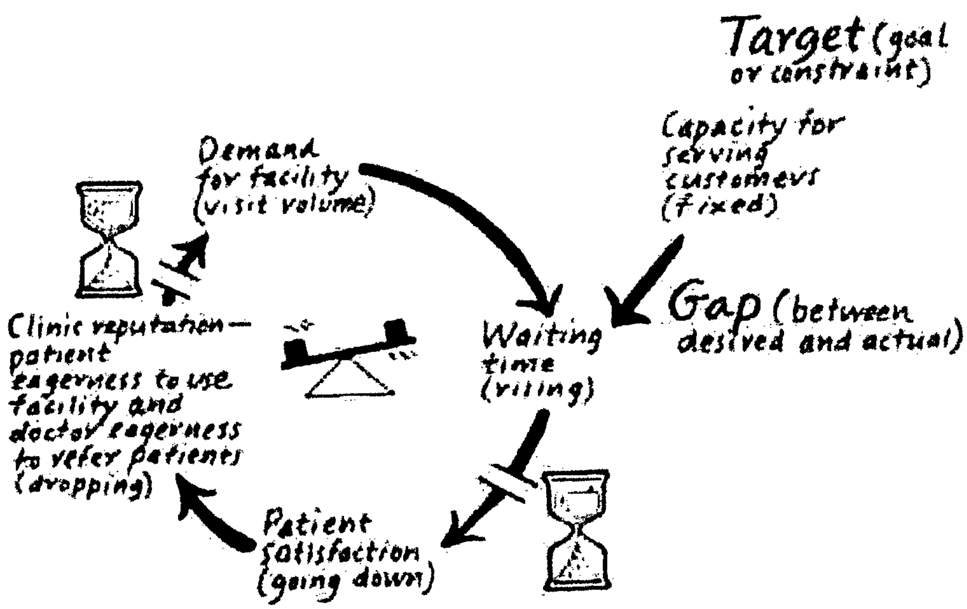
Adapted from General Systems Theory and Haines Associates, 1978.
Based on 1984 and 1995 literature searches and client feedback ever since.
CSM has offices in the USA • Canada • Australia • Korea

APPENDIX B-4: Standard Systems Questions

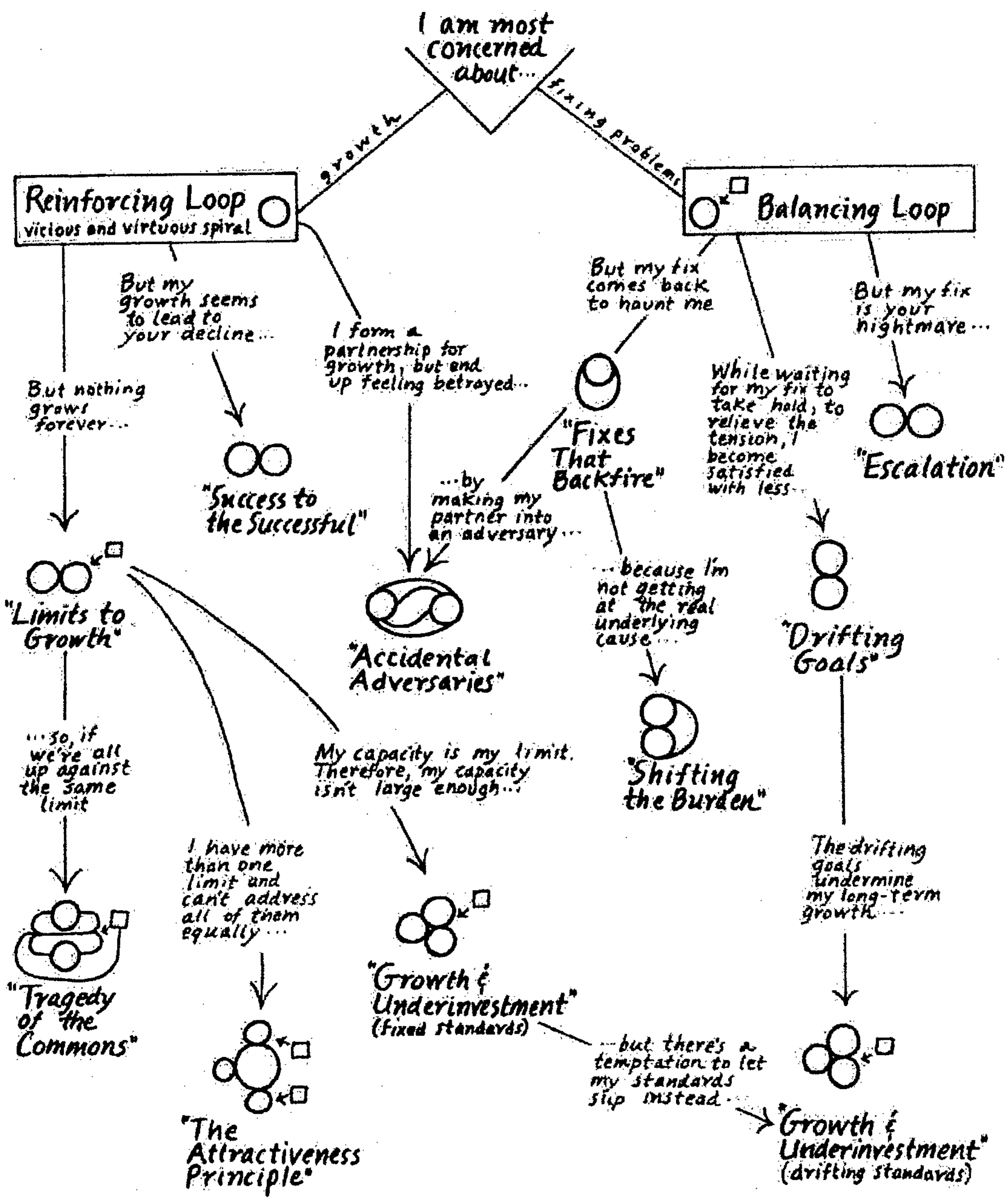
Tool No.	The Applications
1	Systems Preconditions: Question—Which Entity? — *What entity (system or "collision" of systems) are we dealing with, and what are its boundaries?*
2	#1 Systems Question—Desired Outcomes — *What are the desired outcomes?*
3	#2 Systems Question—The Need for Feedback — *How will we know we have achieved the desired outcomes?*
4	#3 Systems Question—Environmental Impact — *What is changing in the environment that we need to consider?*
5	#4 Systems Question—Looking at Relationships — *What is the relationship of x to y and z?*
6	#5 Systems Question—The What or the How — *Are we dealing with ends (the what) or with means (the how)?*
7	The "Iceberg" Theory of Change — *What new process and structures are we using to ensure successful change?*
8	Buy-In and Stay-in — *What must we do to ensure buy-in and stay-in (perseverance) over time, and thus avoid the problem of entropy?*
9	Centralized vs. Decentralized — *What should we centralize and what should we decentralize?*
10	Multiple Causes, Root Causes — *What multiple causes lie at the root of our problem or concern? (That is, what are the root causes of our problem or concern?)*
11	KISS: From Complexity to Simplicity — *How can we move from complexity to simplicity, and to a new strategic consistency and operational flexibility, in the solutions we devise?*
12	The Ultimate Question: Superordinate Goals — *What is our common higher-level (subordinate) goal?*
13	System Dynamics Overall — *What are the typical (and predictable) dysfunctional patterns of human behavior in any organization?*

APPENDIX C: Hard Systems Theory Techniques

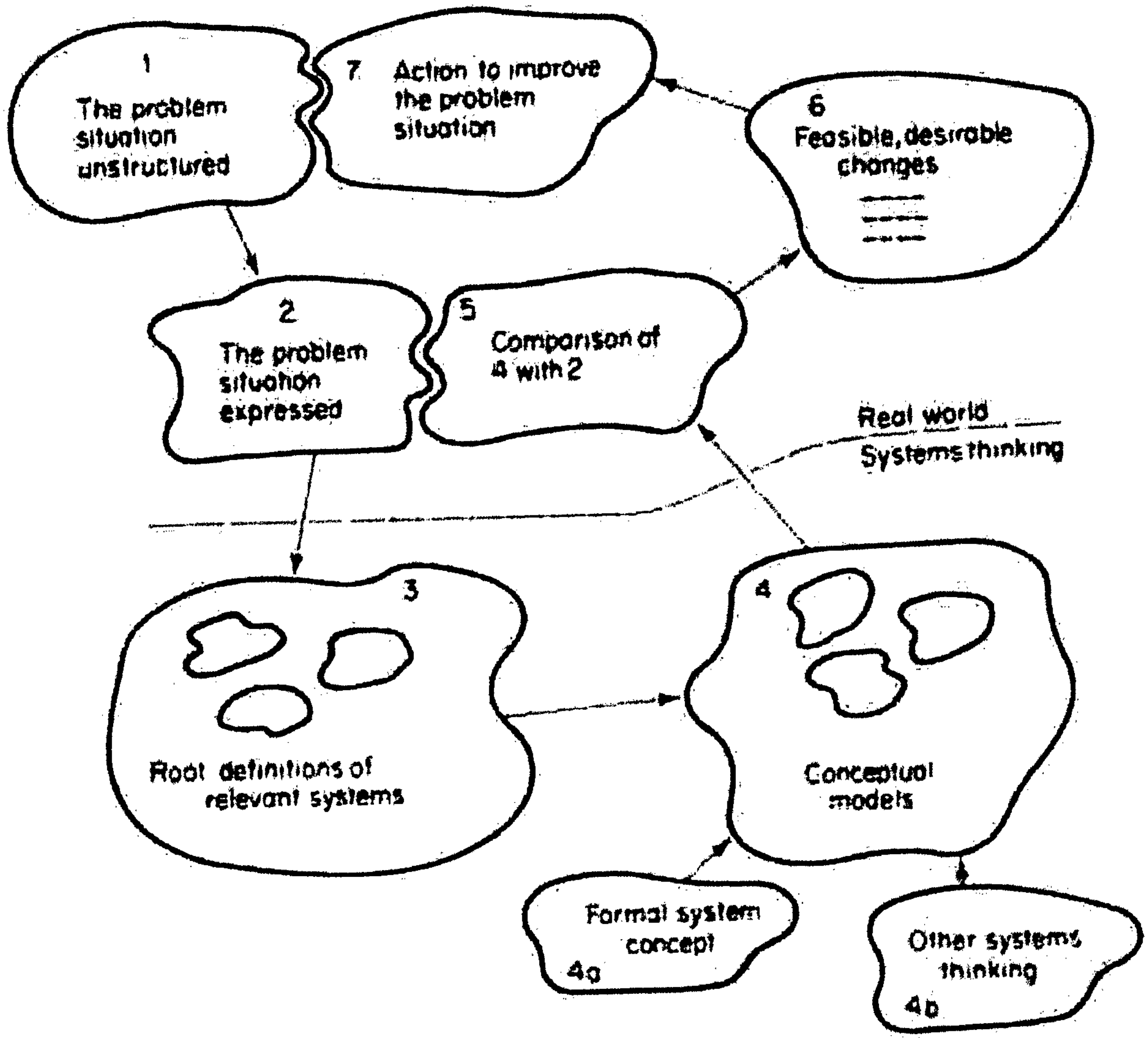
APPENDIX C-1: Example Archetype Application



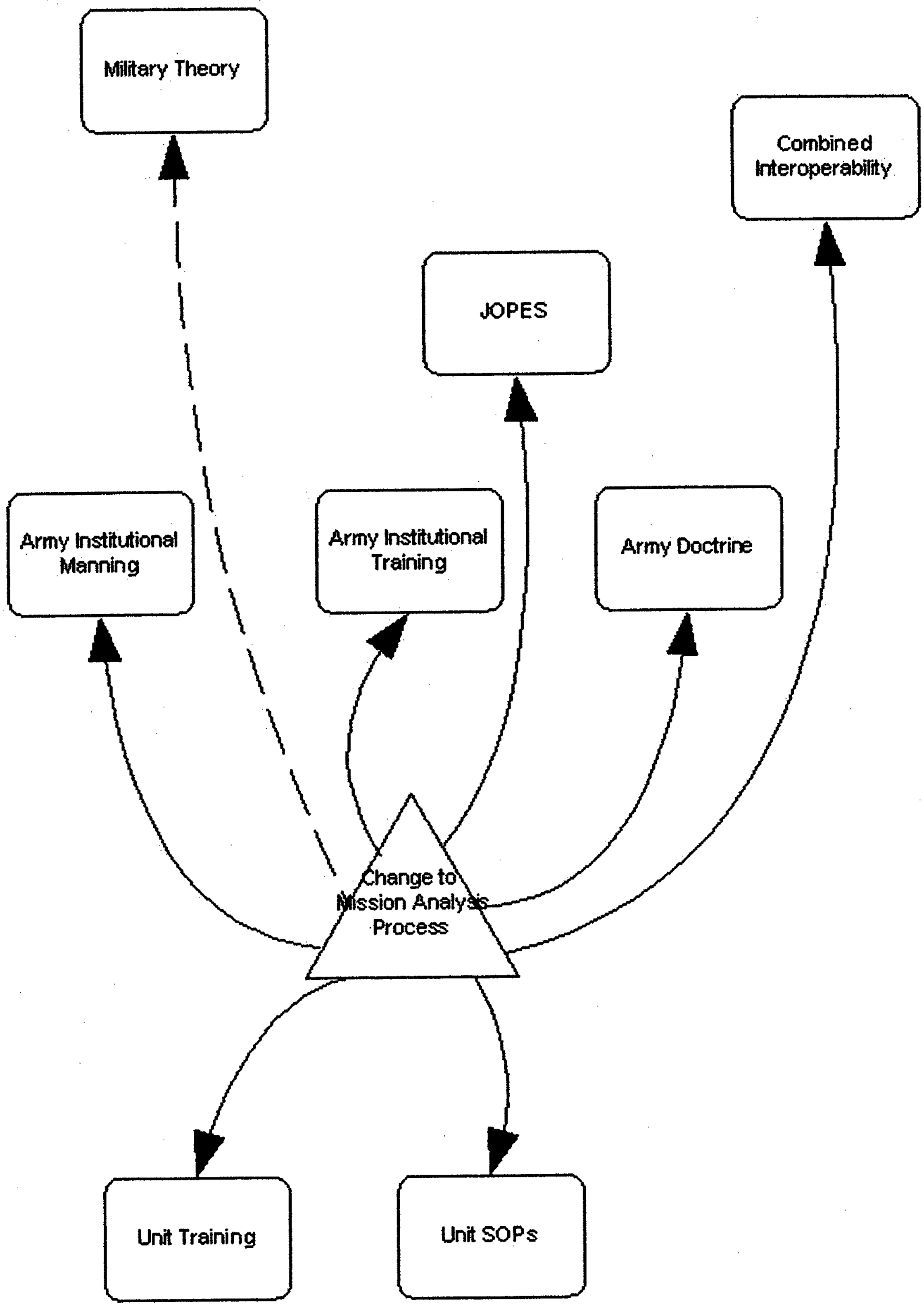
APPENDIX C-2: Archetype Family Tree



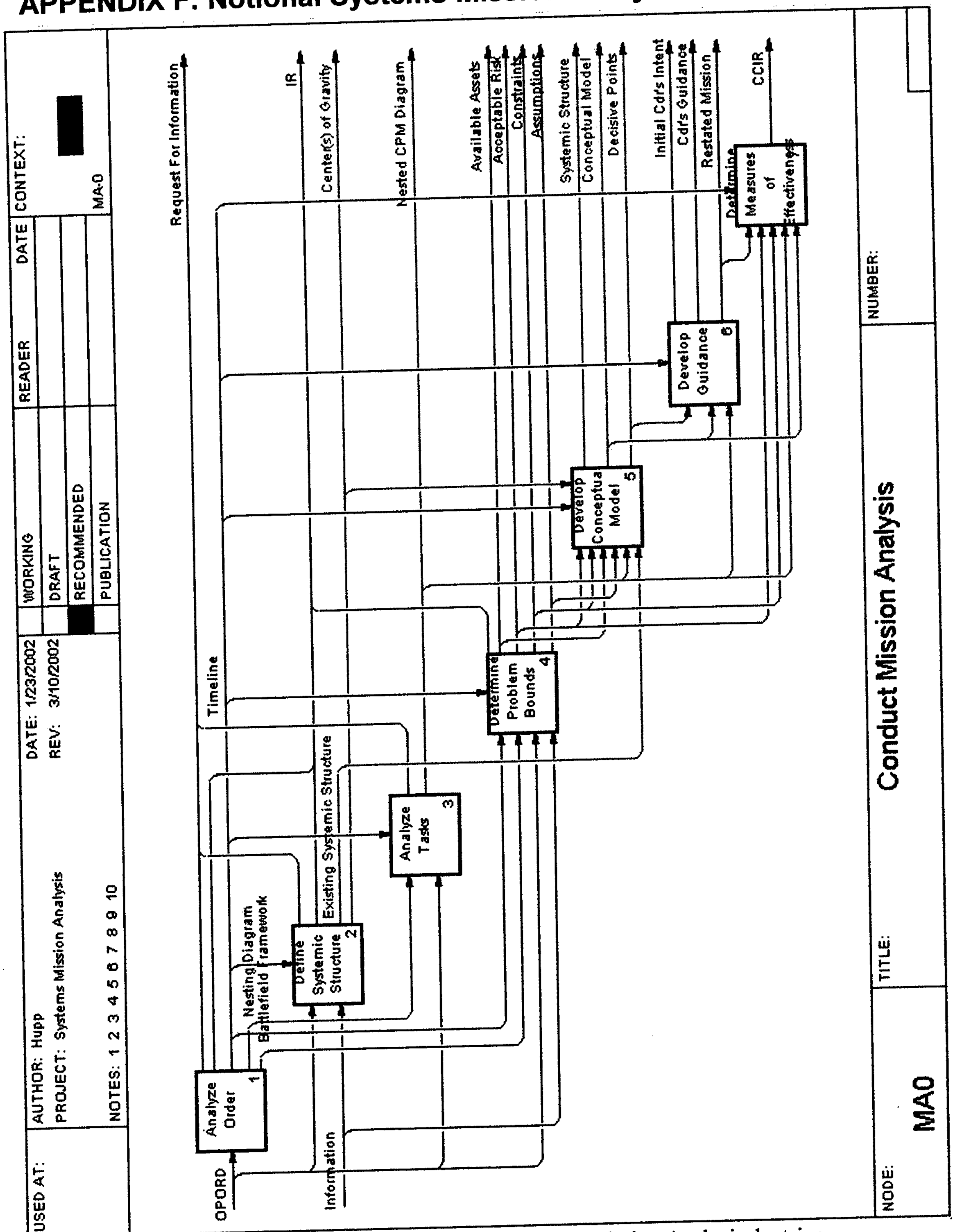
APPENDIX D: Soft Systems Theory Techniques



APPENDIX E: Mission Analysis Influence Diagram

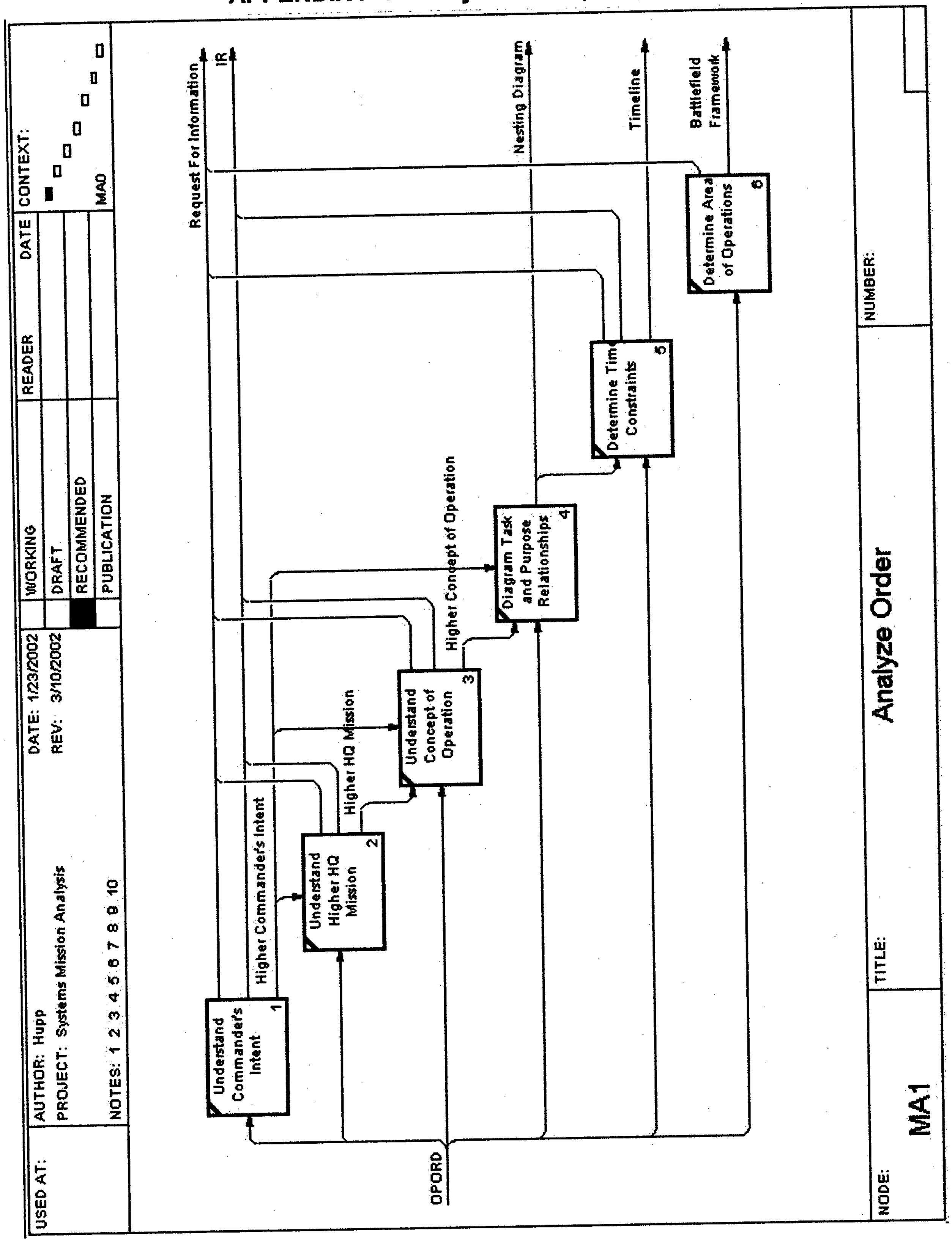


APPENDIX F: Notional Systems Mission Analysis Model (MA0)

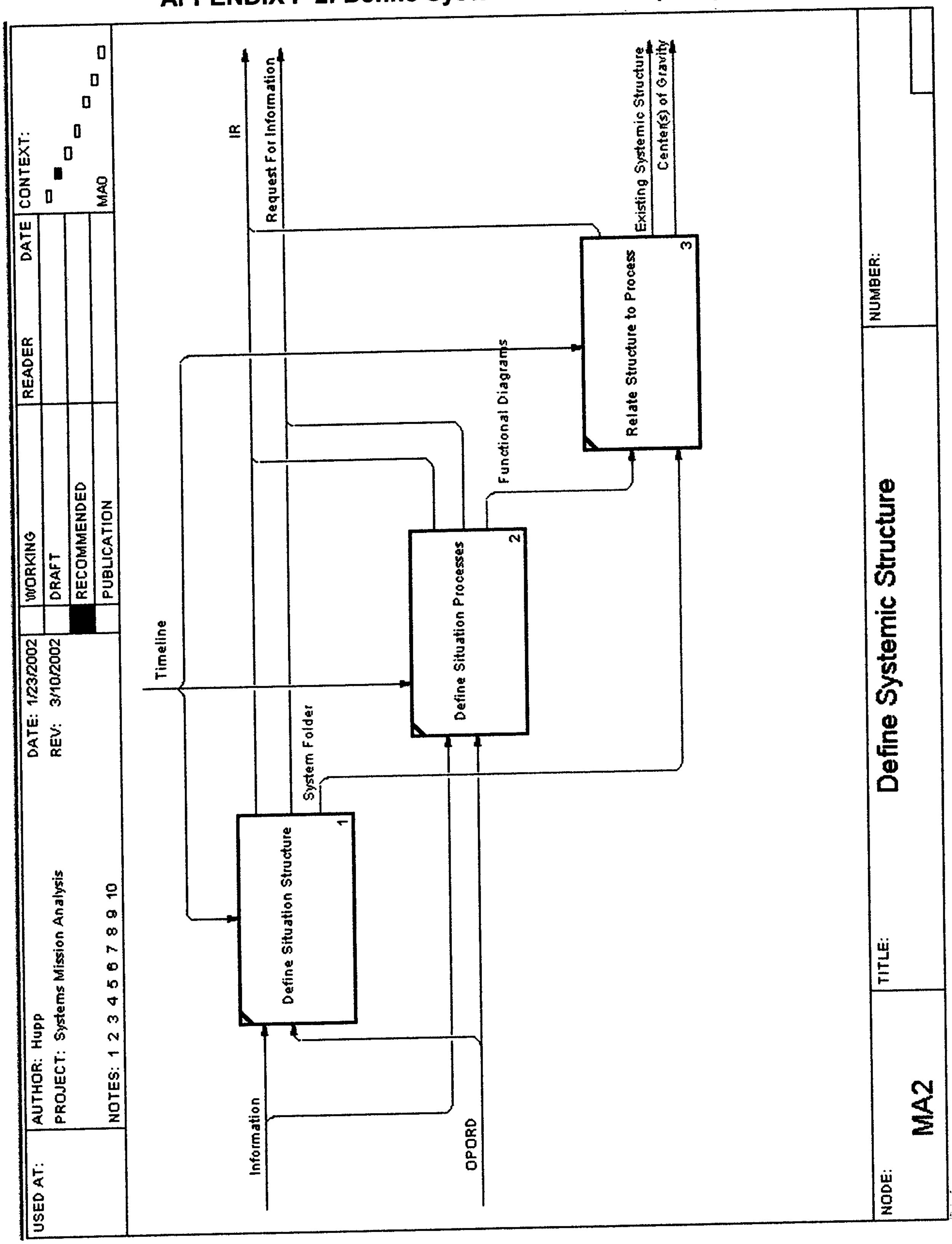


Items in red represent functions and output not part of current Mission Analysis doctrine.

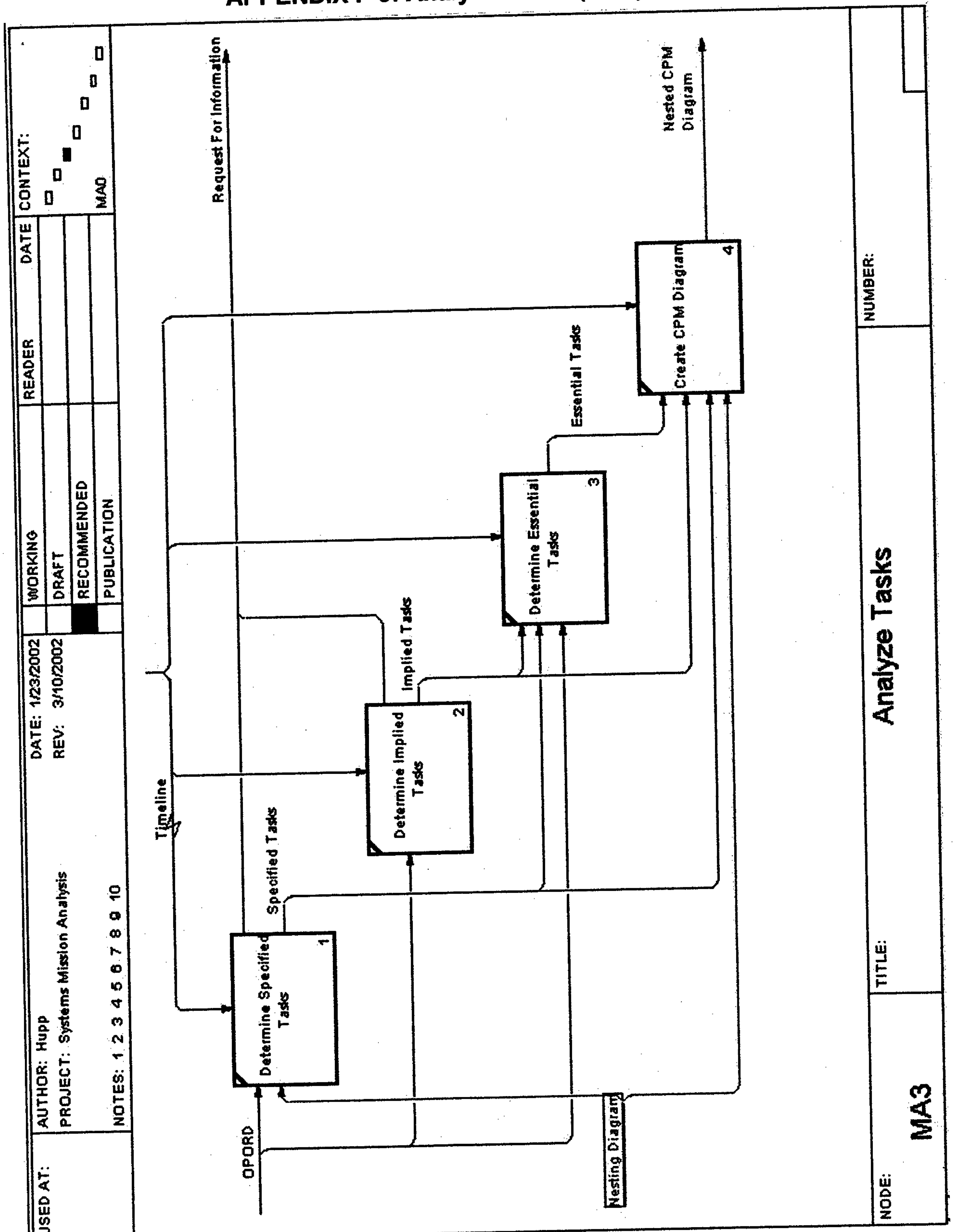
APPENDIX F-1: Analyze Order (MA1)



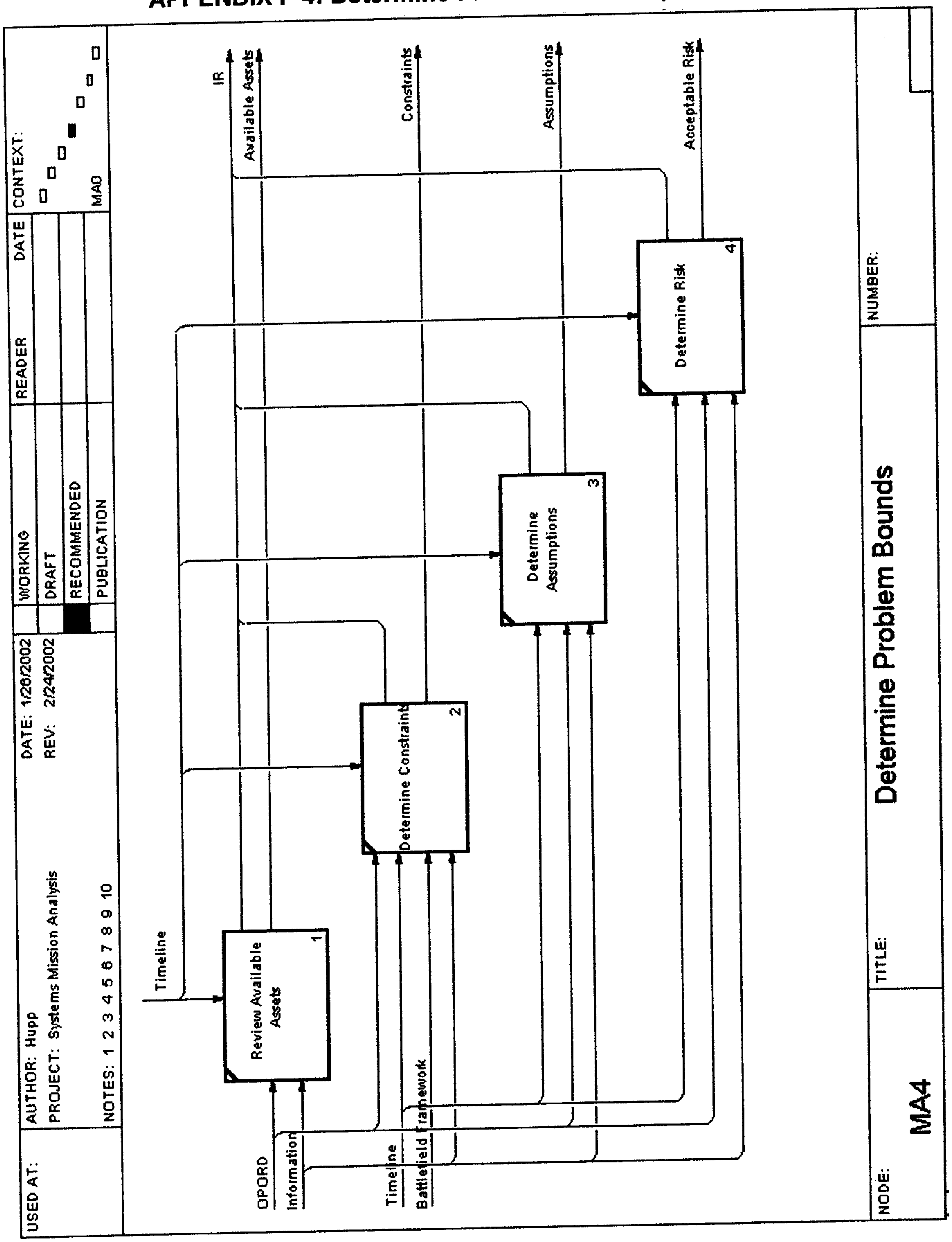
APPENDIX F-2: Define Systemic Structure (MA2)



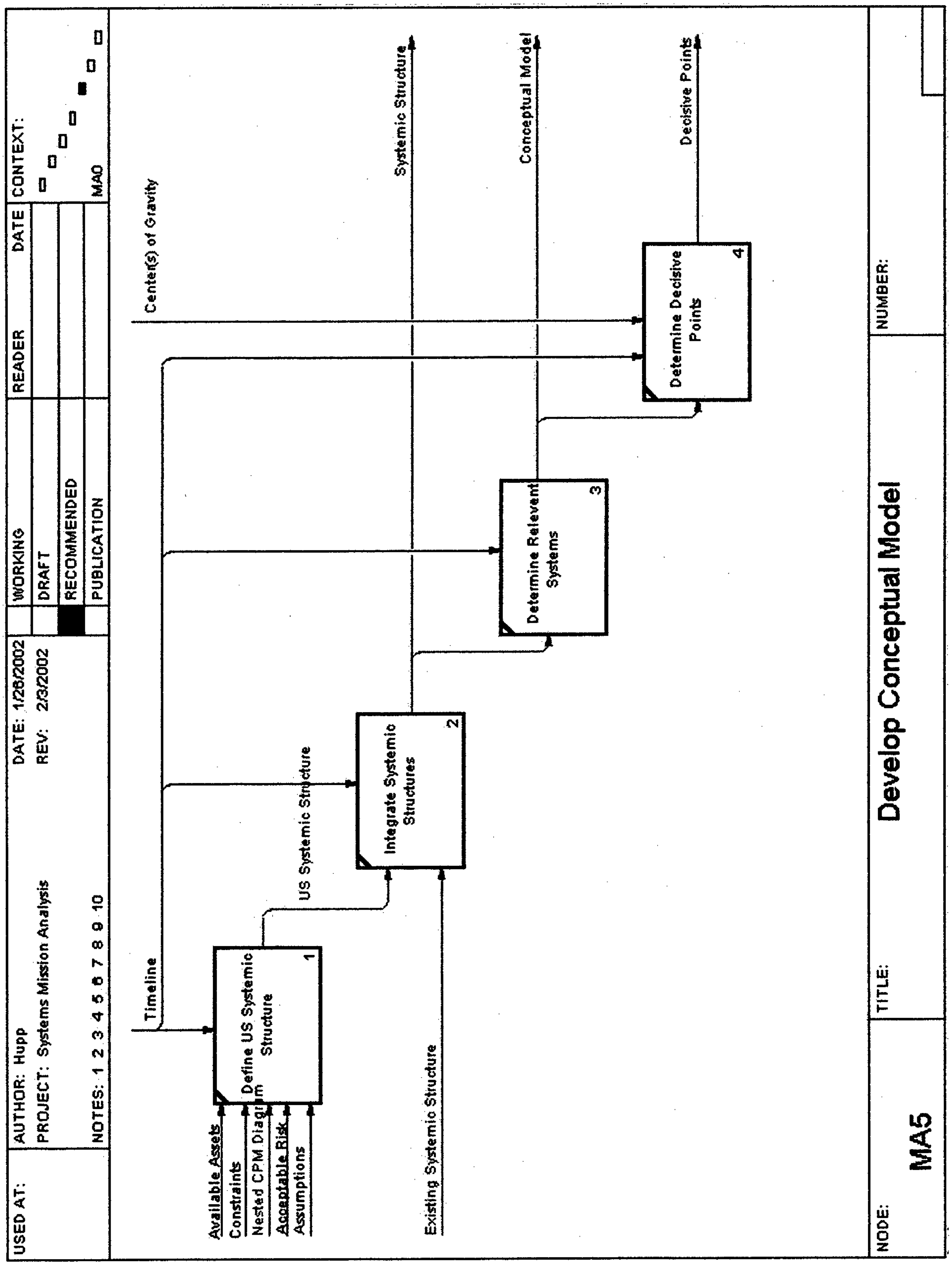
APPENDIX F-3: Analyze Tasks (MA3)



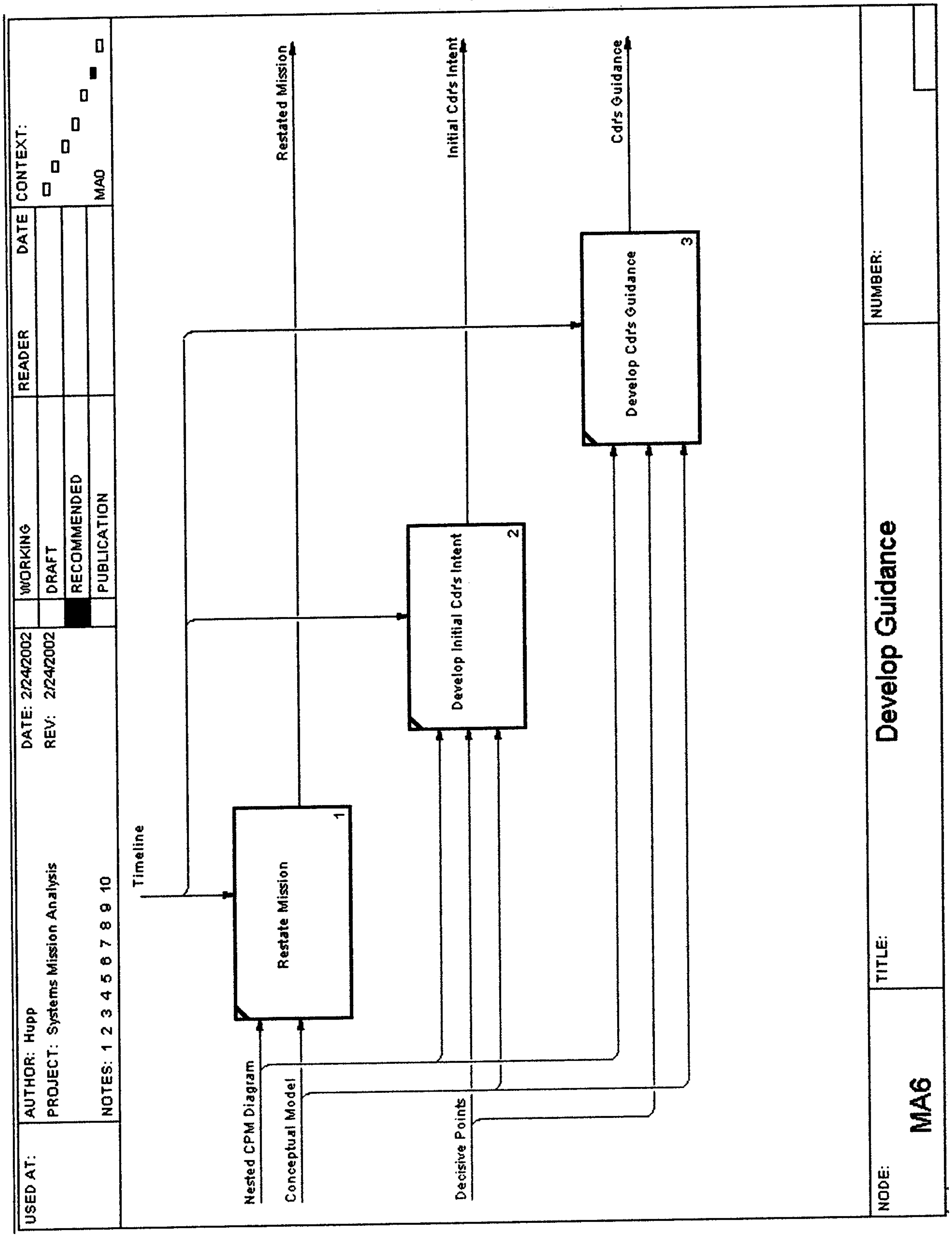
APPENDIX F-4: Determine Problem Bounds (MA4)



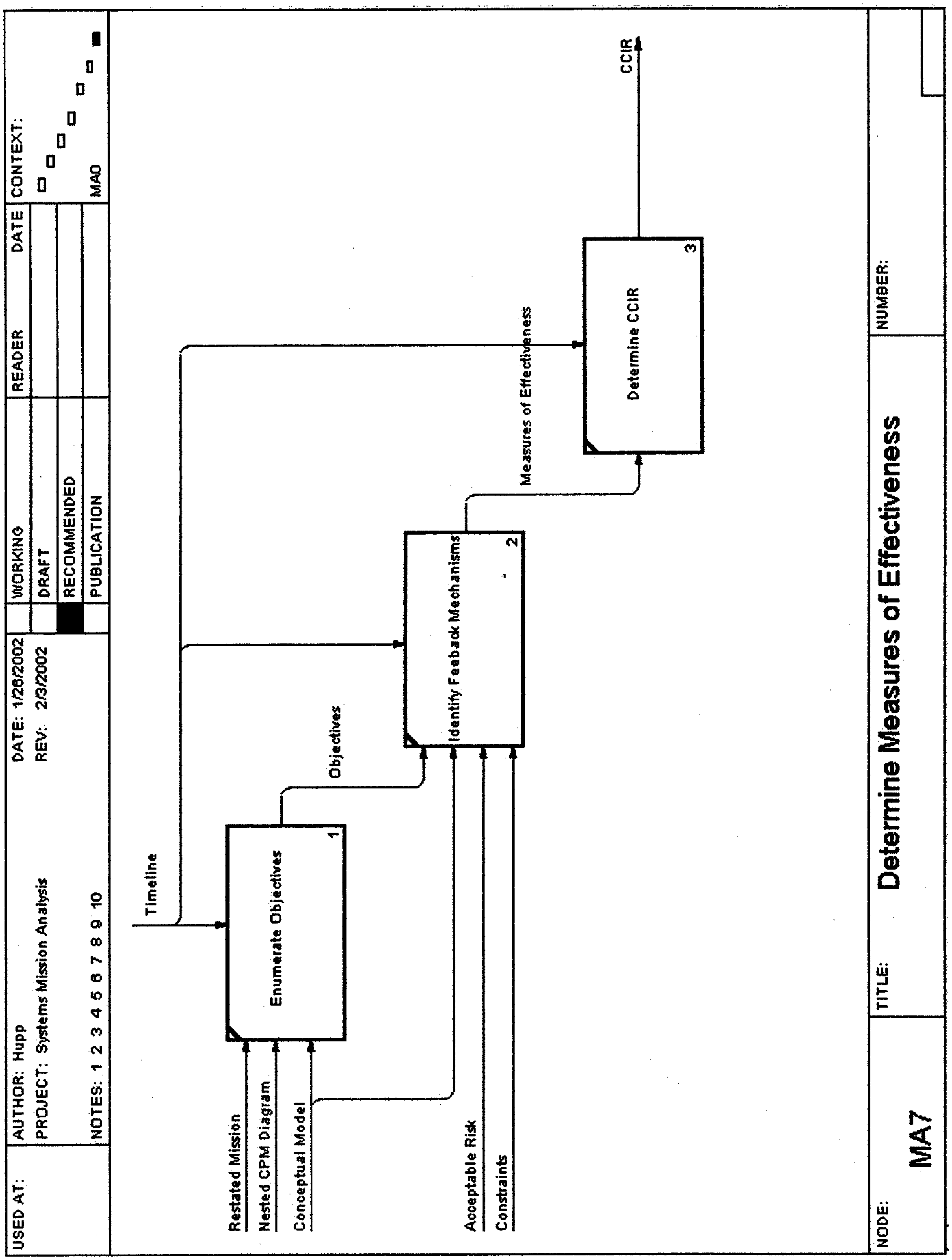
APPENDIX F-5: Develop Conceptual Model (MA5)



APPENDIX F-6: Develop Guidance (MA6)



APPENDIX F-7: Determine Measures of Effectiveness (MA7)



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